JOURNAL OF ECONOMIC ENTOMOLOGY

Official Organ American Association of Economic Entomologists

Vol. 31 October 1938 No. 5

CONTENTS

●

American Association of Economic Entomologists

Paper-Reading Session, Fiftieth Annual Meeting, Indianapolis, Ind., December 27-31, 1937

Notes on the Biology of the Cotton Borer in Pernambuco, Brazil, Louis Pyenson 553

Giving Meaning to the Terms, Brood and Generation, J. A. Hyslop 557

Progress to Date on Studies of Radio Waves and Related Forms of Energy for Insect Control, Thomas J. Headlee and D. Manley Jobbins 559

Some Phases of Entomological Writing from the Viewpoint of the Reader, Roger C. Smith 563

A Proposed National Contest for Entomology Students, F. E. Whitehead 566

Section of Apiculture

Further Developments in Equipment for Heating and Bottling Honey, Edwin J. Anderson 568

Environmental Factors and Size Variations in Honeybee Appendages, S. E. McGregor 570

Observations on Resistance of Some Dark Races of Honeybees to European Foulbrood, C. E. Burnside 573

Vitamin E Content of Royal Jelly and Bee Bread, Mykola H. Haydak and Leroy S. Palmer 576

Section of Plant Quarantine and Inspection

Dutch Elm Disease Eradication; Japanese Beetle Control; European Corn Borer and Gypsy Moth Certification, E. G. Brewer and William Middleton ... 577

Grasshopper Outbreaks in Iowa, C. J. Drake and G. C. Decker 583

Gypsy Moth and Brown-Tail Moth Control Operations During 1937, A. F. Burgess 587

The Present Status of the Japanese Beetle Situation in St. Louis, J. Carl Dawson . 590

Present Status of Barberry Eradication and White Pine Blister Rust Control, S. B. Fracker 591

●

Current Contributions

The Ratio of Lead to Arsenic in Spray Residues from Lead Arsenate, G. W. Pearce and A. W. Avens 594

The Relation of Concentration of Active Ingredient to Insecticidal Efficiency of Dusts, Leslie M. Smith 598

Species and Distribution of Grasshoppers Responsible for Recent Outbreaks, ROBERT L. SHOTWELL 602

Experiments With Phenothiazine and Mosquito Larvae, W. V. KING 610

Effects of Acidity, Alkalinity and Moisture Content of the Soil on Emergence of *Cochliomyia americana* C. & P., ROY MELVIN and R. C. BUSHLAND 611

An Unusual Type of Top-Kill of Ponderosa Pine, K. A. SALMAN 613

Mothproofing Preparations and Methods of Testing, SAMUEL C. BILLINGS 616

Annual Insect Population Records, With Special Reference to the Kansas Summary, ROGER C. SMITH 618

Studies on the Resistance of Apple to the Woolly Apple Aphid, *Eriosoma lanigerum* (Hausm.), G. W. UNDERHILL and JAMES A. COX 622

The Control of Common Red Spider and Thrips by the Use of N,N Amyl Benzyl Cyclohexylamine, C. W. KEARNS and C. C. COMPTON 625

Scientific Notes 630

Editorial 635

Reviews 636

Obituary 637

Current Notes 638

Horticultural Inspection Notes 565, 575, 589

NOTICE TO SUBSCRIBERS

ENGRAVINGS of illustrations which have appeared in Volume 30 of the JOURNAL OF ECONOMIC ENTOMOLOGY may still be purchased by the respective authors or their representatives at one-half cost price. Engravings in the current issue are available under the same terms. This publication reserves the right to destroy those not ordered within 30 days from date of issue.

Orders to ship engravings to authors should be sent to the Editor, at Urbana, Illinois, from whom cost prices may be obtained. Authors will be billed by the Business Manager of the Association for purchased engravings plus mailing charges.

This regulation does not apply to engravings for articles for which the costs of publication have been paid by authors or their representatives. Such engravings will be shipped collect to authors at their discretion if ordered within 30 days from date of publication; otherwise they will be destroyed.

JOURNAL OF ECONOMIC ENTOMOLOGY

Official Organ American Association of Economic Entomologists

Vol. 31 October 1938 No. 5

Notes on the Biology of the Cotton Borer in Pernambuco, Brazil

Louis Pyenson,* *State Institute of Applied Agriculture, Farmingdale, N.Y.*

A cotton borer, *Gasterocercodes* var. of *brasiliensis* Hambl., is one of the major pests of cotton in the northeastern states of Brazil. It is evidently native to the region, but has attracted the attention of cotton growers only in recent years when cotton growing became extensive.

The identity of the cotton borer has been confused until recently with a similar species from Peru described as *G. gossypii* by Pierce in 1915.

Recently E. J. Hambleton (1937) discovered that the borer in São Paulo differed in several respects from the Peruvian species; and therefore he described it as a new species with the name, *G. brasiliensis*. The Pernambuco specimens of the borer, which the writer sent to L. L. Buchanan of the United States Department of Agriculture for comparison with the Peruvian and São Paulo specimens, proved to be distinct from the Peruvian species but very close to the São Paulo species. For the present, as suggested by Mr. Buchanan, the Pernambuco form will be called *G.* var. of *brasiliensis* Hambl.

Little is known about the cotton borer, although it has been a major pest of cotton in Brazil for years. In Pernambuco no studies have been made beyond some superficial observations on the pest.

Pope (1932) and Wille (1934) have studied the related species, *G. gossypii* Pierce, on cotton in Peru. Igelsias (1921), Bondar (1925), and Autouri & Bitancourt (1935) have made some general obsrvations on the life history of the pest in Brazil. The pest was first reported in São Paulo (Vert 1905), but was not identified until 1921 by Costa Lima (1936) who wrongly believed it to be *G. gossypii*.

* Formerly Head of the Entomology Section of the Institute of Agricultural Research in Pernambuco, Brazil.

Mr. Hambleton, at the Instituto Biologico in São Paulo, has been carrying on some intensive investigations on *G. brasiliensis*, but his published work has not yet been obtained.

Host Plants.—The chief host of the borer is cotton, which it appears to attack regardless of variety. The wild plant, "vassourinha de relogio," has been reported (Autori & Bitancourt 1935) as a wild host in Sao Paulo. In Bahia "quiabeiro," *Hibiscus esculentes*, has been found to be heavily attacked (Bondar 1925). No observations were made on wild hosts in Pernambuco, but some such hosts undoubtedly exist.

Fig. 1.—The adult cotton borer.

Description and Habits of Adults.—The adult weevils are 3 to 5 millimeters in length and 1.4 to 2.1 millimeters in width; dark brown in color; and sparsely and irregularly covered with short pale setae, fig. 1. Buchanan refers to the insect in a letter as follows: "The Pernambuco form shows no striking or even tangible differences from *brasiliensis* of which we have a good series, but in the former the prothorax seems a little wider

relative to its length, the elytral intervals are not so strongly convex and the dorsal setae, especially those on the elytra, are longer and coarser and with a greater tendency to form short lines or clusters. I am inclined to believe that the Pernambuco specimens represent a distinct form . . ."

The adult cotton borers are active insects which have the habit of playing dead when disturbed. They are negatively phototropic; may be found during the

FIG. 2.—Injury to young cotton plants showing cambial swellings over borer tunnels.

day hidden on the cotton plants; but usually they are found concealed under dead leaves, dirt clumps and in cracks in the soil underneath the cotton plants. At night they become active and feed on the leaves, petioles and bark of the cotton plants. Their feeding in the adult stage, however, results in but little harm to the cotton plants.

LIFE HISTORY STUDIES.—Under normal conditions in the rainy season the adult weevils deposit their eggs in the bark of the main stems at the soil level or a little below; but in the hot dry season on perennial cotton the adults may deposit their eggs higher up around the axils of the branches. In the interior, where tree cotton is the only type grown, infestations are more common in the upper parts of the plants. This may be due to the long dry season during which soil temperatures become lethal to the insects and force them as a protective adaptation to deposit their eggs some distance from the ground. Adults do not attack seedling plants, but have been observed to attack young plants with roots large enough to accommodate only one larva. They seem, however, to prefer the older plants with the larger roots.

The eggs hatch in a few days, and the newly hatched larvae begin boring downward spirally in the cambium layer, fig. 2. The tunnels at first are small, but as the larvae grow older the tunnels become larger and interfere with translocation to and from the leaves, The larvae do not always confine their activity to the cambium layer, and as they mature they may make burrows in the xylem throughout the root system, fig. 3. Vigorous growing

FIG. 3.—Cotton roots showing tunnels and pupal cells made by the borer.

plants attacked by the borer form cambial growths over the tunnels. This cambial formation very often saves the plants from death, but the adults appear to prefer these cambial growths for egg deposition; and the larvae burrowing in these cause them to enlarge still more until some plants have growths several times

the diameter of their crowns at the soil level. Many plants are greatly weakened by these repeated attacks and finally die, while others survive the attacks and produce a crop.

When the stems and upper trunks of the cotton plants are attacked they also show the cambial swellings, but with a gummy secretion oozing out of them. The larvae first feed in the cambium and later may enter the pith of the stems. The branches and trunks thus attacked are usually broken over by the wind.

The larval tunnels are always filled with frass which the larvae leave behind them. When full grown, the cream colored larvae make oval cells in the xylem of the roots or the pith of the stems, fig. 3. The larvae transform into pupae in these cells. The length of the larval stage is about one month in the dry season and much more in the cooler rainy season. Observations have shown that the larvae do not all develop at the same rate when a plant is attacked by larvae of about the same age. Some larvae appear to be retarded in their growth. In the field, where egg deposition is continuous, as many as 10 borers in all stages of development have been found in a single root.

The borers remain in the pupal stage from 7 to 10 days and then transform into adults which bore their way out of the roots, fig. 4, and emerge from the soil. One complete generation from egg to adult takes about 5 weeks in the hot dry season and about 2 months or more in the cooler regions in the rainy season. The cotton plants may be attacked by at least two complete generations in the growing season. However, since the borers reproduce throughout the year, there are no definite generations, and cotton plants are subject to continuous attack.

INJURY TO HOST.—Usually the first outward signs that the cotton plant shows when attacked by the cotton borer are a cessation of growth and a gradual change in the color of the leaves from a dark green to a reddish yellow. Plants showing these effects may have cambial swellings at their crowns. In the later stages of death the leaves of the cotton plants gradually wilt and fall off. Plants weakened by borer attacks are easily broken over by the wind, but they may continue living in this position. The bolls on attacked plants, if the plants remain alive, mature a few weeks earlier; but usually the plants produce a much poorer crop of bolls.

In many cotton fields the borer may cause the premature death of over 50 per cent of the plants; and frequently nearly 100 per cent of the cotton plants may be infested by harvesting time. However, on good soils the majority of plants survive the attacks; especially if they are planted so as to get the full benefit of the rainy season during their growing period.

FIG. 4.—Cotton roots showing the emergence holes of the adult cotton borer.

ECOLOGICAL OBSERVATIONS.—A series of experiments was set up to study the reaction of adult borers to different environments, and to find out their longevity. Ten adults were placed in each of three Petri dishes. The first contained some dry soil; the second some wet soil; and the third some dry soil with a green cotton leaf added for food every two days. Observations made two days later showed 9 of 10 weevils were hiding in the dry soil on one side of the first dish; 8 of 10 weevils in the open on the side of the second dish one side of the first dish; 8 of 10 weevils hiding under the green leaf or in the dry soil in the third dish. Evidently a damp soil is not attractive to the adults as a hiding place. In the dry soil environment without food all 10 weevils died within 9 days; in the wet soil environment without

food all 10 weevils died within 19 days; and in the dry soil plus green food environment one weevil died 21 days later, one 30 days later, one 35 days later; one two months later, four three months later, and two weevils were still living and active four and one half months later when the experiment was discontinued. Apparently adult weevils can remain living and active for long periods of time in a dry environment provided food is available. No tendency to aestivate has been observed in this pest, and observations indicate that they reproduce continuously during the dry season. Adults have been reared from infested cotton plants throughout the dry season.

TOXICITY STUDIES.—It was considered interesting to test the effects of arsenicals on the adult cotton borers which feed on the cotton plants. Lead arsenate and Paris green were used at the rate of 5 grams to a liter of water. In the laboratory cotton leaves sprayed with these substances were placed in Petri dishes with adults. In the lead arsenate treatment only 4 adults out of 15 were dead in one week, although there was evidence of some feeding. In the Paris green treatment, 20 weevils out of 20 were dead in 48 hours. All borers were living in the check. Experiments in the field, in which plants were sprayed with the two arsenicals at the same rates and then caged with adult borers, produced the following results: In the lead arsenate treatments, 11 of 44 borers were found dead in one week; in the Paris green treatments 27 of 30 borers were found dead within two days; and in the checks all adults were active and feeding. A further test of the two substances in the laboratory substantiated the fact that lead arsenate was not effective against the borers, and that Paris green was very effective. From the above results it appears that Paris green may be used with some hope of success in killing the adult cotton borers in the fields.

CONTROL MEASURES.—Because the cotton borer spends most of its life cycle protected within the cotton plants, it is relatively free of predators and parasites. Muesebeck (1937) has described three new Braconidae, *Heterospilus gossypii*, *H. hambletoni* and *H. annulicornis*, which parasitize the borer in São Paulo. Gahan (1937) has described a new Chalcid, *Eurydinoteloides longiventris*, which is a primary external parasite of the borer in São Paulo. The writer has reared a Chalcidoid parasite from the borer in Pernambuco, but this parasite has not been identified. Parasitism of the borer is so infrequent, however, that it can influence the borer population but little.

Cultural control measures are the most promising for this pest, and they should consist of the following practices:

1. Plant early in the rainy season so that the plants will get the full benefit of the rains for vigorous growth.
2. Plant only on soils suitable for cotton.
3. Plant only those varieties of cotton suitable to the region.
4. Plant only early maturing varieties of cotton.
5. Pull up and burn all infested plants as soon as observed.
6. Harvest crop as soon as possible and pull up and burn all the plants right afterwards.
7. Plow up the field and allow it to lie fallow after the harvest.
8. Burn and destroy all shrubbery around fields at the beginning of the dry season, especially around low damp places; and keep this growth down throughout the year.
9. Pull up and destroy all volunteer cotton that appears during the dry season.

The above recommendations apply only to annual cotton and not to perennial cotton, for the protection of which clean cultural practices are suggested.—1-14-38.

LITERATURE CITED

Autuori, M., and A. A. Bitancourt, 1935. Pragas e doencas do algodoeiro. Instituto Biologico de São Paulo. These **9**: 1–36, c/figs.

Bondar, G. 1925. Pragas do algodoeiro. Bol. do Lab. Pathologia Vegetal, Bahia, **3**: 39–51.

Costa Lima, A. da. 1916. Terceiro Catalogo dos insectos que vivem nas plantas du Brasil. Min. Ag. Rio de Janeiro. p. 344.

Gahan, A. B. 1937. A new Brazilian Chalcidoid parasite of *G. gossypii* Pierce. Rev. de Entomologia 7, fasc. **1**: 18–21.

Hambleton, E. J. 1937. Uma nova especie de *Gasterocercodes* Pierce, broca do algodoeiro no Brasil. Rev. de Entomologia **7**, fasc. **4**: 345–50, c/figs.

Iglesias, F. 1921. Insectos nocivos e uteis ao algodoeiro. Bol. de Agricultura, **17**(12):968–78, c/figs. São Paulo.

Muesebeck, C. F. W. 1937. Three new Brazilian species of *Heterospilus* (Hym., Braconidae), parasites of *G. gossypii* Pierce. Rev. de Entomologia **7**, fasc. **1**: 18–21.

Pierce, W. D. 1915. Descriptions of some weevils reared from cotton in Peru. U.S.D.A. Sec. R. **102**: 1–16.

Pope, J. B. 1932. El gorgojo de la raiz de algodon, o "chupadera." Memoria de la Estacion Experimental Agricola de La Molina, Peru. 4a. Memoria: 131–134. 2 figs.

Vert, G. 1905. Parasitos do algodoeiro na fazenda modelo de Piracicaba. Bol. de Agricultura. **6**(4):156–65, c/figs. São Paulo.

Wille, J. 1934. Viaje de inspeccion a los algodonales en el valle de Piura. Estacion Experimental Agricultura de La Molina, Peru. Informe **5**: 1–20. Marzo.

Giving Meaning to the Terms, Brood and Generation

J. A. HYSLOP, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

The Insect Pest Survey has frequently been embarrassed by criticism of its use of the term "brood," particularly in the matter of numbering the broods, using Brood I for Brood II and Brood II for Brood I. In practically all instances we have found that these criticisms were just or unjust, depending entirely on the interpretation of the terms used and usually involving a confusion between the terms "brood" and "generation." Inasmuch as the scientific and logical approach to any subject is a definition of the terms to be used, we attempted to unravel the snarl into which these terms had apparently become entangled.

DICTIONARY DEFINITIONS.—The dictionaries were of little use to us, as they give about as wide a set of meanings to either term as could well be imagined. "Generation," according to Webster's *New International Dictionary*, second edition, unabridged (1934), has five pertinent meanings:

"1. The act or process of producing offspring; procreation.

"2. Descent; genealogy.

"3. A single step or stage in the succession of natural descent; a rank or remove in genealogy; hence, the body of men, animals, or plants of the same genealogical rank or remove from an ancestor; the mass of beings living at one period.

"4. A mathematical use of the term.

"5. Progeny; offspring; descendants."*

From the same source we find that "brood" has three meanings:

"1. The young of animals hatched and cared for at one time.

"2. The young from the same dam or the offspring of the same mother, especially if nearly of the same age; progeny.

"3. The eggs and the young of the bee."*

DEFINITIONS BY ENTOMOLOGISTS.—The glossaries of entomological terms prepared by various authors were about as confusing. We therefore circularized the collaborators of the Survey for definitions of these two terms. The results of the replies, about 40 of which were sent in, are interesting. Eight entomologists believe that the terms "brood" and "generation" are absolutely synonymous; 28 consider them as more or less distinct; 22 believe that the term "brood" can refer to any stage of the insect; 2 believe that the term "brood" should be confined to the larvae; 2 would confine the term to the adults; and 2 would use this term only when referring to insects that have distinct races appearing in different years, as in the case with the periodical cicada and at least some species of *Phyllophaga*.

As much confusion centered around the numbering of "generations" and "broods" as around the immediate definition of the terms themselves. Six of the entomologists believe that the first brood is the overwintering brood; eight believe to the contrary; 22 believe that the first generation of any given year would start with the first eggs laid that year; one even goes so far as to believe that the first generation would start with the first eggs, whether laid that year or the previous year, hatching that year; two believe that

* Reproduced by permission of the publishers of Webster's New International Dictionary, Second Edition, copyright, 1934, by G. & C. Merriam Co., Springfield, Mass.

the first generation could start with any stage; and four are in favor of starting the first generation with the adults.

In order to give a basis for discussion I shall attempt to define these terms, avoiding as many of the objections as possible to the existing definitions.

A *generation* is the complete life cycle of an insect, irrespective of time, and begins with the appearance or birth of the young, the egg being considered but part of the previous generation.

A *brood* is a contemporaneous and well-defined group of individuals of any active stage of a species, regardless of genealogy, and should be numbered consecutively in each calendar year, or, in the case of insects which require more than one year, may be numbered arbitrarily. For example, the broods of white grubs and the periodical cicada.

DISCUSSION.—One generation may be completed in a few days, as in the case of the housefly, or may endure for years, as in the case of the periodical cicada. *The generation starts when the egg hatches*, or the young are extruded from the parent, and extends up to the normal death of the adult, the next generation starting with the hatching of the eggs of this generation. In this way, it will be seen that generations overlap, even though all of the eggs of a given generation are laid at the same time, as the death of the adult does not necessarily immediately follow egg laying.

The first brood of the codling moth refers to the first brood of adults appearing in the spring. These lay eggs which, on hatching, give rise to the first-generation larvae and in turn the first-generation adults, which are the second brood of moths that year. A brood of mosquitoes can be from the eggs of several generations, or two or more broods can originate from the eggs of a single female. On the other hand, in the case of the housefly the generations are so overlapped that no broods are distinguishable.

The generations are definitely distinguishable, at least by laboratory rearing, no matter how they overlap. This has been demonstrated in investigations on aphids, where the range of the number of generations per year has been accurately determined, even though the insects do not necessarily produce broods.

The most revolutionary feature of these definitions is the starting of a "generation" with the hatching of larvae or extrusion of young. This seems logical, however, as the egg is but the germinal cell and its origin or start of development is determined only with difficulty. "Generation," or beginning, would necessarily imply birth, which is a coming forth. In the case of oviparous animals it occurs when the egg hatches. We would hardly say that the birthday of a chicken is the day on which the egg was laid. In the case of viviparous animals it occurs when the young leaves the parent's body and is a determinable phenomenon and therefore a logical starting point for the generation.

By this reasoning, insects which overwinter in any stage, up to and including the egg, start their first generation in any given year when the first larvae or nymphs emerge either from eggs or from their parents' bodies in that year. This would throw the overwintering larvae and adults and eggs of the codling moth into the last or previous generation of the preceding year, and first-generation larvae would be the resulting larvae that first infest apples or other fruit. Overwintering adults of the plum curculio would be of the previous year's generation or generations. The eggs would hatch into the first-generation curculio larvae. These overwintering adults would constitute the first brood of adults of that year and the adults arising from the maturing of the first generation would be the second brood of that year. Overwintering aphid eggs would hatch into first-generation nymphs, which would develop into stem mothers. The overwintering egg would be part of the sexual generation of the previous year.

This matter is of too vital moment to be hastily passed over. We can hardly consider it scientific to encourage the use of a term and the definition of a term as a matter of personal preference. The terms should have common usage throughout the science, exceptions being made only in grave cases that may arise. For example, the use of the term "brood" in apiculture should remain exactly as it is and will remain exactly as it is regardless of the opinion of scientists. The other usage, however, can be and should be definitely decided by entomologists as a group, and a committee should be ap-

pointed to consider this matter for a year or longer if necessary and bring in recommendations defining these two terms for the action of the American Association of Economic Entomologists.—8-6-38.

Progress to Date on Studies of Radio Waves and Related Forms of Energy for Insect Control*

THOMAS J. HEADLEE and D. MANLEY JOBBINS
New Jersey Agricultural Experiment Station, New Brunswick

From the title of this paper it might be anticipated that the authors propose to review all progress made by them in the study of the effect of radio waves on insects. Such is not their purpose. They wish merely to cover work that has been done by them subsequent to the issue of an article entitled "Further Studies of the Use of Radio Waves in Insect Control," JOURNAL OF ECONOMIC ENTOMOLOGY, **29** (1): 181. Feb. 1936.

POSSIBLE MODIFICATION OF EFFECT OF ELECTROSTATIC FIELD.—Workers who have followed this series of papers will remember that in the last two paragraphs of the above reference the possibility of modulation of the sine wave and the possibility of a study of the resonance phenomenon were designated as fields into which they had never had opportunity to go. Owing to the lack of adequate equipment it has not been possible for them to enter as yet into the field of resonance.

An attempt was made to explore the effect of modulation. Even in this field they found great difficulty in securing any adequate equipment for the purpose. The only modulation which they have been able to try might be called modulation by interruption.

The interrupter consists of a star-shaped copper disc embedded in an insulating base. This disc is rotated at various speeds from 100 to 2000 revolutions per minute by a series motor. It is so connected in the electrostatic field circuit that with each revolution the current is switched off six times. Thus the interruptions ranged from 600 to the maximum of 12,000 times per minute. By using a movable brush contact on the legs of the star and setting it at various points a range from a condition in which the active time is twice the length of the interruption time through a point where the active time is exactly equal to the interruption time to a point where the active time is one-fourth the interruption time can be secured.

Small pasteboard pill boxes filled with whole wheat cereal, and infested with adults and larvae of *Tribolium confusum* Duv. were placed in the electrostatic field and a thermometer inserted through the side of the box into the midst of the whole wheat cereal and the infesting insects. Many runs were made, and the upshot of the whole series of tests was that the insects were unharmed until the cereal reached a lethal temperature, when all were killed.

With the interrupter out of the circuit, approximately 1.5 minutes were required to reach the lethal temperature. With the interrupter in the circuit and the brush set at the center where the active time was twice as long as the interruption time, approximately 1.5 minutes were required to reach the lethal temperature. With the interrupter in the circuit and the brush set where the active time was exactly equal to the interruption time, approximately 3 minutes were required to reach the lethal temperature. With the interrupter in the circuit and the brush set at the tip of the star-leg where the active time was one-fourth of the interruption time, more than five minutes were required to reach the lethal temperature and it was noted that the average current flow was greatly reduced by this last setting.

These results were obtained in all the different interruption speeds tested, which were 600, 1500, 3000, 6000, 9000 and 12,000.

Evidently, the suspicion that alter-

* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

nately exciting and releasing the organism by means of these interruptions should show some effect other than heat is without foundation. It is realized, of course, that the maximum number of interruptions here are not to be compared with some other forms of modulation. It is sufficient to say that with this particular form of modulation no appreciable effects other than the ordinary heat effect were shown.

PRACTICAL APPLICATION OF ELECTROSTATIC FIELD TO DESTRUCTION OF JAPANESE BEETLE.—In view of the fact that the influence of moisture has been shown to be a very powerful factor in the development of heat in materials subjected to the electrostatic field it seemed that the first step should be to test soils of different moisture content. Accordingly, washed quartz sand, a ceramic clay known as "black clay" and a typical soil mixture of sand, loam and humus were selected for this study. The frequency employed was 6,250,000 cycles per second and the voltage gradient 2,046 volts per inch. The results are set forth in table 1.

Table 1.—The relationship of soil heating to moisture content for certain soil materials in the radio frequency electrostatic field.

SAMPLE	DEGREES F. RISE IN 2 MINUTES		
	Washed Quartz Sand	Black Clay	Sand Loam Humus
Powder dry	4	36	49
Powder dry + 2.5% H_2O	91	85	107
Powder dry + 5.0% H_2O	104	78	106
Powder dry + 10.0% H_2O	91	54	50
Powder dry + 20.0% H_2O	56	10	8
Saturated	39	1	4

This table shows, as might be expected from previous work of this sort on grain, that a small amount of moisture increases the speed with which the heat is developed while a large amount of moisture decreases this speed. This table also shows that the composition of the material treated influences the rate of heat production at any given moisture content. Roughly, the optimum moisture for the maximum increase in heat ranges from $2\frac{1}{2}$ to 5 per cent.

The fourth column of table 1 entitled "sand, loam, humus" refers to a soil very closely related to the soils on which the studies set forth later were made.

The next step seemed to be to determine the temperature required in soil to kill grubs and eggs of the Japanese beetle. About 25 third instar grubs were acclimated, by exposure to room temperatures 79 to 80 degrees F. for two days, in the sandy loam soil above mentioned. This soil ranged from 10 to 15 per cent moisture and was included in one-half pint cardboard cartons. These cartons contained approximately 300 grams of soil.

Treatments were made at 4,838,000 cycles and 3660 volts potential per inch and the temperature was brought up to the values shown in table 2. The samples were then cooled for 30 minutes, examined and the results recorded. The samples are grouped according to the maximum temperature.

Table 2.—The effect of radio frequency soil heating on grubs of Japanese beetle.

TEMPERATURE GROUPS	DEAD	TOTAL	PERCENTAGE KILL
107–109 degrees F.	28	72	38.5
114–116 degrees F.	50	75	66.7
120–122 degrees F.	74	74	100.0
124–126 degrees F.	72	72	100.0
142–144 degrees F.	48	48	100.0

In the temperature group 120–122 degrees F. and on into the higher temperatures everything is killed.

Fifty eggs of the Japanese beetle, *Popillia japonica* Newm., were placed in the same kind of soil enclosed in similar cartons under the same acclimation conditions as the grubs. They were treated at 4,800,000 cycles per second and 3660 volts potential per inch. No grubs hatched from eggs exposed in soil which had been heated to 120 degrees F. or more.

The third step seemed to be to test the soil ball plant tolerance at temperatures required to kill the Japanese beetle in the type of soil with which the writers were dealing. The treatments made on the soil balls were at 3,500,000 cycles with 4000 volts potential per inch. The weight of each soil ball and of the plants was 4 to 6 pounds. The diameter of the soil ball was about 6 inches. Treatment was given October 21, 1935, and final examination and record of data made on April 1, 1936. Four plants of the following narrow-leaved evergreens were treated: *Pinus*

Table 3.—Effect of soil ball heating on evergreens.

NAME OF PLANT	TEMPERATURE RANGE	NUMBER OF PLANTS	NUMBER DEAD
Pinus thumbergi	120–126 degrees F.	4	3
Picea excelsa	126–140 degrees F.	4	3
Thuja occidentalis	120–149 degrees F.	4	3
Juniperus chinensis	119–139 degrees F.	4	2
Checks	66– 68 degrees F.	1	0

thumbergi, *Picea excelsa*, *Thuja occidentalis* and *Juniperus chinensis*. One plant of each of the varieties was left untreated as a check. Results are shown in table 3.

In view of the fact that the elimination of grubs from *Ilex crenata* and *Azalea hinodigiri* had proved difficult it was decided to try treatments on these two species. Balled specimens of *Azalea hinodigiri* 6 to 8 inches tall with 4-inch soil balls were treated at a frequency of 4,800,000 cycles and 3500 volts potential per inch. Likewise potted *Ilex crenata* in 3-inch pots were treated at a frequency of 4,800,000 cycles per second and 3360 volts potential per inch. The treatments were given August 24, 1935, and final examination made October 2, 1935. Results are given in table 4.

The work, from which the data recorded in all these tables came, was done with extreme care, and the errors that crept in were reduced to a minimum. In summarizing the results it may be said that as soon as temperatures of the soil reached a point where the destruction of all grubs took place the plants under test were very seriously injured and in many cases killed.

Again we come in contact with the influence of water, and the effect of differential heating between insect and plant tissues in the electrostatic field disappears.

LETHAL EFFECT OF VISIBLE AND NEAR VISIBLE LIGHT RAYS.—By extended observation the writers became convinced that when insects of various species are placed 10 to 12 inches away from the energy source and subjected to the rays of a 260-watt incandescent therapeutic lamp fitted with the ordinary type of therapeutic lamp reflector, they are promptly killed. Likewise by extended observation they became convinced that the rays from a white light Mazda lamp of the same wattage in a similar arrangement would not kill these insects promptly. The same conclusion was reached when a 450-watt quartz mercury lamp was used.

Obviously, here was a situation in which insects subjected to the same or approximately equivalent energy outputs in relation to distance from source were affected differently, and the question immediately arose as to why this was so.

First of all, the writers satisfied themselves that when insects were killed they were destroyed by heat regardless of the source from which the power came. They reached this conclusion because it was found that when sufficient wattage in relation to distance from the source was provided the insects were killed by the Mazda white light and by the quartz mercury but in all cases that they were not killed until a lethal heat was reached.

Naturally it was anticipated that difference in penetration of the insects by the energy from different sources was responsible, and an effort was made to measure the penetration of energy from these different sources through the insects' integument and overlying appendages.

As the quartz mercury ultraviolet source and the incandescent infrared source both emit energy in the visible range and in view of the additional fact that insect destruction had been obtained

Table 4.—Effect of soil ball heating on *Ilex* and *Azalea*.

NAME OF PLANT	TEMPERATURE RANGE	NUMBER OF PLANTS	NUMBER DEAD
Ilex crenata	88–138 degrees F.	6	6
Ilex crenata	66– 68 degrees F.	2 (Checks)	0
Azalea hinodigiri	97–149 degrees F.	13	13
Azalea hinodigiri	66– 68 degrees F.	2 (Checks)	0

with them, it was thought best first to measure their unmodified energy transmission through insect appendages. Table 5 sets forth the results of such measurements.

Table 5.—Transmission of energy from mercury "Uviarc" and incandescent infrared radiation sources through wings of *Periplaneta americana* (L).

Insect Appendages	Per Cent Transmission	
	Infrared Visible Source	Ultraviolet Visible Source
Forewings		
Individually	61.5	25.4
In combination	42.8	10.7
Hing wings		
Individually	42.1	15.2
In combination	16.4	6.0
All wings—folded	6.4	1.1

This table shows at once that the transmission rate of energy from the incandescent therapeutic source was from two to six times as great as from the quartz mercury. These very limited data give apparently a good reason why more power was required to kill insects with the quartz mercury source than with the incandescent therapeutic lamp source.

It then seemed advisable to measure the penetration of the different sections of the spectrum covered by these two energy sources. Table 6 sets forth the results.

This table clearly shows that the lowest transmission takes place in the ultraviolet and that increasing transmission takes place as the waves grow longer and finally fall in the infrared. This finding, of course, reinforces the conclusion from the previous table and indicates the reason why the incandescent therapeutic source is a much more powerful source of lethal energy for insects.

In view of the fact that many insects on which such sources of energy might be used are inclosed in their food material, a study of the penetration of the energy from these two sources through certain food materials was made. The results are set forth in table 7.

This table shows that penetration of energy from the infrared section of the

Table 6.—Transmission of radiant energy through wings and integument of the cockroach, *P. americana*.

Spectral Zone	Corning Filter Number	Wave Lengths of Radiation Angstrom Units	Per Cent Transmission	
			Both Forewings	All Wings Plus Dorsal Integument
		Incandescent		
Near infrared	255	7,500–35,000	30.0	2.40
		Mercury lines between		
Ultraviolet	986	2,967– 3,680	1.0	0.00
Blue	554	4,047– 4,359	12.1	—
Green	401	5,461– 5,804	18.6	—
Blue—infrared	306	4,047–10,140	19.8	1.38
Green—infrared	338	4,920–10,140	20.1	2.01
Red—infrared	241	6,908–10,140	30.9	2.40

Table 7.—Transmission of radiant energy by certain host materials.

Host Material	Thickness of Layer	Infrared Corning No. 255 and Quartz Filter 7,500–35,000 Å	Mercury-Quartz Arc Ultraviolet and Visible Mercury Lines 2,700–10,140 Å
		Per Cent Transmission	Per Cent Transmission
Wheat cereal	1/32 inch	0.83	0.220
White wheat flour	1/32 inch	0.14	0.068
Whole wheat flour	1/32 inch	0.14	0.110
Wheat bran	1/8 inch	0.14	0.000
White corn meal	1/32 inch	0.27	0.068

incandescent therapeutic lamp was materially greater than from the mercury quartz type and that a very limited depth of coverage of these food materials over the insect is adequate for its protection from injury.

GENERAL CONSIDERATIONS.—Efforts to secure an improvement in the lethal effect of the electrostatic field for insects by a process of interruption have proved ineffective.

A careful and intensive study of the utilization of the electrostatic field for the destruction of Japanese beetle grubs and eggs in the soil ball of certain kinds of ornamental plants was carried out and led to the conclusion that any soil temperature sufficiently high to insure destruction of the grubs and eggs would do serious, and in many cases fatal, damage to the plants, the earth balls of which were treated. This result seems to be due to the elimination of the differential heating effect through the presence of the normal amount of moisture in the soil and in the roots of the plant.

Energy transmission through insects and their common food materials, and consequently the prompt development of lethal heat within the mass and within the bodies of the insects, through the use of the electrostatic field has been proved to be eminently practicable. The same objective cannot be reached by the employment of infrared rays because the infrared rays do not penetrate readily and deeply as do the strains and stresses in the electrostatic field. Still less is it possible to utilize visible light and ultraviolet because the penetration of insects and their food materials by these sources of energy is even more shallow than is the penetration obtained with the infrared.

Heat is apparently the lethal agency. By use of the electrostatic field it can be produced very quickly and throughout the mass of both insects and their food materials because the heat is generated in all parts of the mass at the same time. Of the sources of radiant energy studied, ranging from the ultraviolet to the infrared, heat is produced at the surface of the mass and deep heating occurs only by conduction or in a manner very similar to the production of heat within the mass by subjecting it to high external temperatures.—1-7-38.

Some Phases of Entomological Writing from the Viewpoint of the Reader*

ROGER C. SMITH, *Kansas Agricultural Experiment Station*

There are few subjects in entomology which have not been the object of more or less writing and investigation. Science progresses by the addition of individually unimportant new facts and observations, or the correction of previous statements. These additions are often widely scattered, and the bulk of scientific literature has become almost overwhelming. The task of keeping informed on a subject, even in a specialized field, becomes increasingly difficult.

CORRELATING MATERIAL WITH PREVIOUS CONTRIBUTIONS.—Before publishing new information, a true scientist seeks to learn what is already known about his subject or the phenomenon on which he writes. This requires a patient and thorough review of the literature dealing with the subject. A scientist endeavors to extend the borders of science by adding knowledge to that which is already known. Perhaps he may wish to make known new principles or to elaborate upon old ones.

It is a duty to science and a courtesy to one's colleagues for a scientist to make his discoveries and observations available to others. This is usually done through the medium of some form of publication. With the rise in cost of publication, there has come an insistence on the part of journals for shorter papers, which in the main is laudable. In order to attain brevity, some journals limit the number of pages or the length of the bibliography and review of the literature. As a result, only a small group of specialists or

* Contribution No. 458, from the Department of Entomology, Kansas Agricultural Experiment Station.

workers on the same problem is likely to have the necessary background to understand and appreciate the content of such papers. The necessity of limiting the cost of publishing papers is understood and appreciated generally. The continuation of some scientific journals is actually endangered by high costs and low income. In general, the right sort of brevity in writing improves the paper. But failure to include a sufficient critical review of previous writing on the subject, to enable the reader to correlate any new facts with what has gone before, seriously weakens the contribution. A mere reference to previous papers, as for example: "Important observations have been made on this subject by A(1910), B(1915) and C (1925)," is neither a review of the literature nor a correlation of the new information with the old. It is poor economy to neglect to point out how the current observations or results agree, disagree or amplify previous work. This can often be done in a few lines that are well worth the effort and cost.

This growing tendency to omit mention of previously published work gives the impression of presenting all facts and observations as new and original. It opens the writer to the suspicion that he is not acquainted with what has already been done on the subject. Failure to review the literature thoroughly before publishing often results in unnecessary additions to scientific bibliography.

ABSTRACTS OR SUMMARIES.—Scientific papers, particularly the longer ones, should include a well-thought-out abstract or summary, because most readers read the summary first. A summary serves three purposes: (1) It enables the reader to determine whether or not the paper is of sufficient interest to him to warrant his reading it; (2) it enables the teacher and general reader to keep themselves informed on the trend of current biological investigations with a minimum of effort; and (3) it enables any reader to peruse the article more intelligently than he could otherwise. With the main facts in mind, the reader can give attention to details. A good summary enables an abstractor to prepare a better abstract of the paper than would otherwise be the case. Scientific writings are intended to be usable records. The reader should, therefore, be given due consideration in the presentation of experimental observations.

NEED OF SUBJECT SUMMARIES.—There is a serious need in entomological literature for summary publications. Uvarov (1928, 1931) has pointed the way with model summaries of book size of the literature on grasshoppers, insects and climate, and other subjects. Gradinger (1936) has prepared a laudable example of such a summary, now in the second edition, on pyrethrum flowers. The excellent review of the literature on wireworms by Thomas (1930) is an example of an experiment station bulletin, while the writer's modest summary on Pharaoh's ant (Smith 1934) may be cited as such a review in the form of a journal article.

Summaries on such well-known insects as the Hessian fly, chinch bug, codling moth, boll weevil and similar forms would be of book size, and their preparation, publication and distribution would be a suitable undertaking for the American Association of Economic Entomologists to sponsor and, if necessary, subsidize. Such summaries, properly prepared, would reduce to a minimum the reading necessary in order to secure an intelligent background on a subject. Small summaries could be published and distributed as bulletins or journal articles. *Biological Reviews* and the *Quarterly Review of Biology* are serving a most useful purpose in this field. There are no publications in entomology comparable to *Physiological Reviews* and *Resumptio Genetica*, though few branches of science have a greater bulk of literature or are advancing faster.

REFERRING TO PAPERS IN A BIBLIOGRAPHY.—Three methods of referring to a paper in the bibliography are used: the name-date, name-number and number. There are marked advantages to the reader in the name-date method (*e.g.*, Adams 1934). It serves as well as any method to locate the paper in the appended bibliography and conveys connotations of the work, viewpoint, location and the previous work of the author. In addition, it shows how recently the cited contribution was made.

PLACE OF DATE IN A BIBLIOGRAPHIC ENTRY.—Best library practice favors placing the date, when listing a paper in a bibliography, at the end of the reference rather than after or under the author's name. This method is now used by the

American Library Association and librarians generally, in *Biological Abstracts*, and in the various librarian helps published by the H. W. Wilson Company, such as the *United States Catalog of Books* and the *Agricultural Index*. Library practice stresses author and title, while the entomologist stresses author and date. The difference in effort required in locating the date at the end of a reference over that following or under the author's name is trivial.

The omission of the subject from a reference reduces its bibliographic value. However, abbreviating a bibliography in this manner is infinitely more desirable than eliminating the reference altogether. It is not an uncommon fact that the bibliography of a paper is its most useful part to some readers or at some times. Calling attention to an important published paper, previously overlooked or the importance of which has not been fully realized, is a contribution comparable to new facts about the subject in question.

Listing papers in a bibliography at the end of a paper in the order to which they are referred in the text, which would be neither alphabetically by authors nor chronologically, as when the chronology of the subject is to be emphasized, is the worst of all methods. There are no important arguments in favor of this objectionable method and there is much to condemn it.

BIBLIOGRAPHY AS FOOTNOTES.—Some writers follow the plan of listing seven or less bibliographic citations in a paper as footnotes rather than at the end of the papers when reference is made to each paper only once. This rule is followed by some journals as for example the *Journal of Agricultural Research*. This method brings the reference to the reader's attention while he is reading the page upon which it is mentioned. However, many journals, notably the JOURNAL OF ECONOMIC ENTOMOLOGY, follow as editorial practice the placing of all references regardless of number at the end of the paper. Supporting this practice is the elimination of the difficulty in handling footnotes in the print shop when setting up page proof. The use of "l. c.," "op. cit." and "vide" in making repeated reference to footnote bibliographic citations, as practiced especially by writers in history, is irritating to the reader and generally objectionable.

CONCLUSION.—This brief discussion has included the following points: correlating published research with what has been done and recorded previously; the value of abstracts and summaries; the need of published subject summaries to reduce the space devoted to literature reviews and to enable the investigator in obtaining a background for his reading and work with a minimum effort; positions of the date in references; methods of referring to the bibliographic entries in the text of a paper; and finally the advantage of placing references at the end of a paper rather than listing them as footnotes.

It may remind the young writer that there are good reasons for the present day style of entomological writing. All writers need to be reminded at times that the reader deserves first consideration in our writing. Accuracy, clarity, brevity, convenience and a sufficient background supplied by the author to enable the reader to correlate his contribution with what has gone before appear to be essentials of the best scientific writing.—3-30-38.

LITERATURE CITED

Gradinger, C. A. 1936. Pyrethrum flowers. McLaughlin-Gormley Co. Minneapolis, Minn. 380 pp.

Smith, Roger C. 1934. A summary of published information about Pharaoh's ant, with observations on the species in Kansas. Kan. Acad. Sci. Trans. **37**: 139–49.

Thomas, C. A. 1930. A review of research on the control of wireworms. Pa. State Col. Sch. of Ag. and Exp. Sta. Bul. **259**. 52 pp.

Uvarov, B. P. 1928. Locusts and grasshoppers. Imp. Bur. of Ent. London. 352 pp. 9 pl.

Uvarov, B. P. 1931. Insects and climate. Ent. Soc. of London. Trans. **79** (Part 1). 247 pp.

A HEARING to consider a federal quarantine because of white-fringed beetle infestations in Alabama, Florida, Louisiana and Mississippi, is being held at New Orleans, September 15. Such infestations, according to the U. S. Bureau of Entomology and Plant Quarantine, are now known to exist in 22 counties. Regulatory action thus far has consisted of quarantines placed by the infested states.

A Proposed National Contest for Entomology Students

F. E. Whitehead, *Oklahoma Agricultural and Mechanical College, Stillwater*

Most entomologists who are connected with an agricultural college, or have been affiliated with such an institution in the past, are to a greater or less degree familiar with the various contests which agricultural students enter. Oklahoma Agricultural and Mechanical College, Stillwater, has taken an active part in many such contests, and the general opinion of the various departments that enter teams is that they are of much value to the student body as a whole as well as to those who are successful in "making the team."

For several months the writer has been considering the possibilities of a similar contest for students of entomology. In order to obtain an opinion more general than that which could be acquired at his particular institution, he sent out questionnaires inquiring of the deans and coaches their opinions concerning the contests to 25 institutions situated at various localities in the United States.

Of the 78 replies received, 75 were favorable and 3 unfavorable. The coaches on the whole were very enthusiastic concerning the advantages and lack of disadvantages of the contests. The deans were less enthusiastic and more inclined to think the contests might be overemphasized and require regulations, but, without exception, expressed their opinions that they were definitely of value. The three unfavorable replies came from coaches rather than deans. The number of favorable replies encouraged the writer in his belief that entomology students should have the opportunity of sharing the benefits to be obtained through contests and led to the preparation of this paper proposing a contest for entomology students.

Plan of the Contests.—In the presentation of the following plan, the writer does not contemplate that it should be adopted in the presented form, but merely that it should suggest an outline which might be worked into a suitable plan for an entomology contest, should this or any other group consider it worth while to give it further consideration. The plan in brief is as follows:

A list of approximately 200 economically important insects and closely related arthropods should be drawn up from which the contest material would be chosen. This list would be sent to each institution requesting it and would be turned over to the coaches and prospective contestants of the respective institutions. At the beginning, such a list might be shorter than the one suggested in order to give the institutions time to assemble all needed material.

At the time of the contest a specified number of exhibits would be prepared and each contestant would have a definite length of time to examine each display. Each exhibit might be:

1. Any stage of any insect on the list. If it is any other than the adult stage, it should, of course, be definitely characteristic of that particular insect. The exhibit might contain two or more stages.

2. The injury caused by any insect on the list, provided that it is characteristic of the particular species.

3. A description of the injury and insect causing the same, similar to material found in letters of inquiry.

4. Any combination of the above that might prove desirable.

From his examination of the exhibits, the contestant would (1) give any of the following information that might be called for in the instructions placed on or near each exhibit: (a) scientific name, (b) common name, (c) host or hosts, (d) stage of over-wintering, (e) place of over-wintering, (f) stage injurious, (g) place of oviposition, (h) distribution, (i) control; (2) compose a suitable reply for letters of inquiry; (3) answer any other question the committee might consider pertinent and fair.

From the written replies, it would be comparatively easy to determine the winning individuals and teams.

It is thought that each of the main divisions of the American Association of Economic Entomologists might conduct such a contest at each of its annual meetings and that the winning team of each section would be eligible to enter a similar contest, held in connection with the annual meeting of this society, to determine the national champions. Such contests in

my opinion would have many distinct advantages as well as disadvantages. The following lists of each are drawn from the questionnaires previously mentioned and are supplemented by additions by the writer.

DISADVANTAGES.—Following are disadvantages:

1. Much time would be required by members of departments who in many cases are already finding it difficult to keep up their regular duties.
2. Departments would have to incur considerable expense in order to obtain all the materials necessary for the training of a team.
3. The travel and hotel expenses of the team members, particularly of those having to travel great distances, would be great, and in some cases students would not be financially able to stand the expense.
4. The training and trips would require absences from classes as well as time from studying for classes and would have a tendency to cause a "let down" in class interest before and after contests.
5. Too few students would be benefited.
6. There would be a tendency to overemphasize either the contests or certain phases of entomology.

DISCUSSION OF DISADVANTAGES.—My reply to the first three objections (time and expense of faculty members, students and departments) is that seldom, if ever, can anything that is really worth while be obtained without the sacrifice of time and effort and the incurring of some expense. Possibly the advantages of such contests might make these sacrifices worth while. The statements made at the beginning of this paper indicate that those in other lines of work have made such sacrifices and have considered themselves amply repaid for them.

In many cases, a part of these objections have been met by finding sponsors who have assisted in conducting and financing such contests. The writer has corresponded with the representative of an entomological supply company and has been assured that he will cooperate in every way possible to make such contests workable and successful. Further attempts to find sponsors have not been made, but it seems possible that a sufficient number might be found to lessen materially the objections just mentioned. Entomological societies such as this might render assistance. One of the more common methods used by many institutions of meeting the problem of student travel expense is to send the coach and a car belonging to the institution to the contest or meeting; the coach takes the team members free of charge. Thus, the only expenses the student must meet personally relate to hotel, food and incidentals.

Objection no. 4 (absences from classes and "let downs") would have to be overcome by advantages obtained and that as well as no. 6 (overemphasis) could be held to a minimum by drawing up some rather strict rules governing the contests. Such a procedure would from the beginning eliminate one of the main objections found by those who have had experience in other contests.

The remaining objection (too few students benefited) could be overcome by encouraging large numbers to try out for the team and by granting some credit for obtaining a certain degree of proficiency in this type of effort.

ADVANTAGES.—The possible advantages, like the disadvantages, are drawn largely from the replies to questionnaires and are listed under two headings. First, those to student contestants and, second, those to faculty members, departments of entomology and entomology in general.

Advantages to student contestants:

1. Students would be inspired to unusual efforts in a phase of entomology that is all too often neglected by economic entomologists, and therefore the amount of useful information they would obtain in college would be increased.
2. Such contests would have a stimulating effect upon the classes from which team members were selected and upon the subject in general.
3. Success in making the team would be rewarded by the opportunity of making valuable contacts, not only with many outstanding entomologists from various parts of the county but also with many of the more ambitious and brilliant undergraduate students in entomology. Such contacts, together with the broadening effects of travel and keen competition, should give students better insight into the entomological profession and, still further, inspire them to put forth their best efforts.

4. Such contests would have a tendency to develop in the contestants a pride in their institution, self-confidence, power of close observation resourcefulness, honesty and sportsmanship.

5. The team members would bring home to those left behind a certain amount of inspiration and other beneficial characteristics just mentioned.

Advantages to faculty members, departments of entomology and entomology in general:

1. Such contests would force departments to obtain a more nearly complete line of demonstration materials in order to prepare a team for the contest. It has been the writer's experience that many departments have for years intended to obtain such material but for some reason have "put it off" until a more convenient time. Such departments would undoubtedly be benefited by entering a team and obtaining the much needed material at once.

2. Assisting contestants to prepare the best possible type of letter for the contests, and permitting these same students to look over our own correspondence with the critical attitude they would necessarily have to assume, would have a tendency to improve it. The number of papers appearing recently on entomological correspondence would indicate this to be of importance.

3. The contests would force faculty members to do some "brushing up" to keep their students from getting too far ahead of them. It is my belief that most of us need the inspiration and the opportunity that the preparation of a team for such a contest would offer to post ourselves anew on many insects that are of major importance. For instance, I am wondering how many of this group who do not live in infested territory and who have never worked with the European corn borer could have positively identified one had it flown into our office last summer and fallen on our desk. Or how many of us under similar circumstances could positively identify the alfalfa weevil, the pink bollworm moth, the Mediterranean fruitfly, the gypsy moth, the vetch weevil or any one of numerous other pests of major importance.

Should such contests result in quicker and more accurate determination of insect specimens by any considerable number of present or future entomologists or general agricultural students, this in turn would probably result in:

1. Earlier recognition of new infestations which might easily be of tremendous benefit.

2. Increased efficiency of insect surveys.

3. More accurate information concerning the distribution and spread of injurious or other interesting species of insects.

Should the above mentioned results be obtained, even in a small measure, they would have a very definite tendency toward raising the standards of the entire entomological profession. It appears to the writer that anything that offers even remote possibilities of such results is worthy of careful consideration and, therefore, the above plan is recommended as one worth considerable attention.—1-7-38.

Further Developments in Equipment for Heating and Bottling Honey

EDWIN J. ANDERSON, *Pennsylvania State College, State College*

At the Atlantic City meeting a series of slides was shown and verbal description given of plans for the construction of an electrically heated dry chamber to be used for liquefying honey and rendering beeswax. Since the time of that meeting a number of these chambers have been built to conform to the plans given. One beekeeper built three of these chambers and has kept records of the cost of current used for heating certain amounts of honey.

CONSTRUCTION OF CHAMBERS.—A brief description of the chambers might be given: first so that the results obtained may be better understood. These chambers are 5 feet high by 5 feet deep by 8 feet long, inside measure. Seven-eighth inch tongue and groove material was nailed on a frame of two-by-fours. A space was left which was large enough for installation of

a good sized door of the type used on refrigerators. Four inches of rock wool was placed between the two-by-fours to act as insulating material. The rock wool also reduces materially any danger from fire hazard. Inside the rock wool and on the two-by-fours was nailed a layer of hard pressed composition material which is similar to wood. (Kiln dried tongue and groove wood may also be used.)

Two of the chambers are used for storage; in each of these, there is a 1.8 kilowatt strip heating unit. The third chamber is used for liquefying crystallized honey. In this one there is a 3.6 kilowatt unit. The units are placed on the center of the rear wall with two pieces of galvanized sheet iron on either side of the units. The sheet iron is 1½ inches from the units and 1½ inches apart. There is 3 inches of rock wool between the one sheet next the wall of the chamber and the wall itself. This is to prevent any danger of the chamber catching on fire from the heat that is generated by the unit.

The units are 12 inches from the floor and the edges of the galvanized iron are 8 inches from the floor. The iron includes a space 8 inches wider than the units and forms a sort of chimney so a draft of air passes over the units. A fan is placed on the floor of the liquefying chamber to provide a forced draft over the heating units. The space at the sides of the heating unit is enclosed by the sheet iron while the top and bottom are open, providing for free circulation of air.

The value of the two storage chambers has not been thoroughly studied as yet; so little will be said about them at this time. The liquefying chamber has proved its value.

This chamber holds 44 60-pound cans of honey which are placed on slatted shelves. The upper shelves can be removed. They are placed on the cans below after the lower part is filled. The slatted nature of the shelves permits a free circulation of air around the cans, which are placed in the chamber about two inches apart.

RECORD OF THE HOWELL CHAMBERS.—The following records have been obtained by Roy Howell, the owner of the chambers. The first record was for a batch of 44 60-pound cans, the contents of which were heated and liquefied to approximately 130 degrees F. An additional batch of 14 cans were heated at the same time without shutting off the chamber. The cans were cleaned and returned to the chamber and dried. In all, 75 kilowatts of current were used.

A second batch was heated from the same or room temperature of about 66 degrees to 150 degrees F. The amount of honey was 4800 pounds, all of which was crystallized honey. For this job 45 kilowatts of current were required.

FIG. 1.—Central view of the heating chambers owned by Roy Howell.

Another batch of 2520 pounds in jars and pails, heated to 150 degrees F., required 45 kilowatts of current. The cost of the current was 2½ cents per kilowatts, which makes the cost about 0.04 cent a pound for heating the honey. The time required for heating this batch of honey was approximately 24 hours.

CONVENIENCE.—The convenience of the chamber is one of its valuable features, since the electric current can be used without mess or damage to the containers. The thermostat prevents excessive temperatures which are likely to damage the honey; the maximum temperatures for any kind of honey may be accurately con-

trolled. The chamber is of value also in rendering beeswax from cappings and for drying 60-pound cans.

After the chamber has been used a few times and the operator becomes acquainted with it, all that is necessary is to place the honey in the chamber, turn in the switch and leave the chamber alone until the end of the approximate time that is required for proper heating.

A more nearly complete description of the chamber and its equipment is given in circular 188, Division of Agricultural Extension, the Pennsylvania State College, entitled, "Entracting Equipment for the Honey House."—2-7-38.

Environmental Factors and Size Variations in Honeybee Appendages*

S. E. McGREGOR, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

Beekeepers generally assume that one colony of bees, *Apis mellifera*, L., is as good as another colony of similar strength in nurturing larvae, so long as these larvae have come from good queens. Since worker bees and queen bees develop from identical eggs and their great difference in the adult stage is due mainly to the food received during the larval period, and since this food is secreted by worker bees, it seems worth while to learn more about the ability of worker bees to affect the larvae they nurture. If a difference in nurse bees exists, then queen breeders should select not only superior breeder colonies but superior cell-finishing colonies as well.

As there is greater difference in length of tongue between the Caucasian and the Italian bees than in any other anatomical characteristic of these two races, tongue length was selected as the index to determine the effect of nurse bees. Two normal colonies in two-story, 10-frame deep Langstroth hives were used. One of these, colony 3 had a Caucasian queen, and the other, colony 6, had an Italian queen. These queens had been introduced the previous year and their wings clipped for identification.

TRANSFERRING EGGS TO ANOTHER COLONY FOR DEVELOPMENT.—The first experiment consisted in comparing the tongue length of bees that had developed in their parent colony with tongue length of bees that had developed in the colony opposite the one in which the queen had placed the eggs. Four groups of bees were collected, as follows:

(1) Eggs laid by the queen in colony 6 and left for development in colony 6.

(2) Eggs laid by the queen in colony 6 and placed for development in colony 3.

(3) Eggs laid by the queen in colony 3 and left for development in colony 3.

(4) Eggs laid by the queen in colony 3 and placed for development in colony 6.

The colonies were manipulated in a routine manner. In the first week the Caucasian queen in colony 3 was placed in a nucleus-introducing cage on a worker comb for one day. She was then released below the excluder, and the comb containing her eggs was placed above. The Italian queen in colony 6 was similarly treated. The following week the queen in colony 3 was again caged for a day, and when she was released her comb of eggs was marked and placed for development above the excluder in colony 6. Again colony 6 was similarly treated, the eggs being placed in colony 3. This alternating procedure of having each colony rear a comb of eggs from its own queen one week and eggs from the opposite queen the following week was continued for three and one-half months. Twenty days after the eggs had been laid the comb was again caged to retain the emerging bees until a sample of them could be taken.

The bees taken in the samples were killed in cyanide bottles and then preserved, until measurements were made, in a solution made up of 10 parts of 40 per cent formalin, 3 parts of glacial acetic acid, 15 parts of glycerin, 60 parts of 95 per cent ethyl alcohol and 12 parts of distilled water. This solution did not cause shrinkage, and it kept the specimens from hardening and becoming unsuitable for measuring.

* A contribution from the Southern States Bee Culture Field Laboratory, Division of Bee Culture, Bureau of Entomology and Plant Quarantine, located at Baton Rouge, La., and maintained cooperatively by the Louisiana State University and the U. S. Department of Agriculture.

Tongue length was determined by measuring the combined length of the mentum and the ligula. The triangular submentum was not included in the measurements. Tongues to be measured were removed from the bees with forceps, passed through a warm 10 per cent potassium hydroxide solution, placed on a glass slide in a drop of glycerin and covered with a cover glass. Measurements were made at once in a dark room with a projector, which threw the brightly illumined outline of the object upon a calibrated white chart. Measurements were made to the nearest 0.05 millimeter. The apparatus was checked with a micrometer scale each time a series of measurements was made.

Table 1.—Tongue lengths of honeybees reared in parent colony and of those transferred to another colony for rearing.*

Group	Colony in Which Eggs Were Laid	Colony in Which Eggs Were Developed	Date Sample Was Taken	Number of Bees in Sample	Tongue Length, in mm.	
					Average	Range
1	6	6	July 15	26	5.90	5.70–6.05
			July 19	71	5.90	5.20–61.5
			July 31	81	5.93	5.70–6.20
			Aug. 7	65	5.96	5.70–6.15
			Aug. 16	84	5.97	5.70–6.30
			Sept. 3	70	5.93	5.70–6.15
			Sept. 12	50	5.95	5.75–6.15
			Sept. 26	33	5.99	5.65–6.15
			Oct. 10	63	6.03	5.80–6.25
			Oct. 24	62	5.98	5.80–6.25
			Oct. 29	47	5.99	5.75–6.15
2	6	3	July 15	8	5.90	5.75–6.00
			Aug. 10	54	5.93	5.50–6.10
			Aug. 23	73	5.92	5.70–6.15
			Sept. 5	90	5.96	5.70–6.20
			Sept. 19	28	6.00	5.75–6.25
			Oct. 2	61	6.02	5.80–6.20
			Oct. 17	31	5.99	5.85–6.25
			Oct. 31	25	5.99	5.90–6.10
3	3	3	July 15	45	6.11	5.90–6.30
			July 22	84	6.13	5.90–6.25
			July 31	97	6.14	5.55–6.40
			Aug. 7	59	6.18	6.00–6.35
			Aug. 16	82	6.24	5.90–6.50
			Sept. 3	69	6.10	5.90–6.30
			Sept. 13	86	6.19	5.80–6.35
			Sept. 26	76	6.18	5.80–6.40
			Oct. 9	63	6.23	5.80–6.45
			Oct. 26	62	6.24	6.00–6.50
			Oct. 30	48	6.19	6.00–6.35
4	3	6	July 17	78	6.19	6.00–6.40
			July 27	93	6.23	5.90–6.50
			Aug. 10	65	6.25	6.05–6.45
			Aug. 23	87	6.16	5.80–6.50
			Sept. 7	71	6.19	6.00–6.40
			Sept. 21	58	6.09	5.80–6.25
			Oct. 4	66	6.19	5.90–6.40
			Oct. 18	94	6.20	6.00–6.40

* Standard deviations and standard errors were calculated, but as they were consistently 0.10 mm. and 0.01 mm., respectively they are not included.

The measurement data are presented in table 1, and the averages are presented graphically in fig. 1. These data reveal at once the difference in tongue length of bees from the two colonies. The tongues of the Caucasians in group 3 were con-

sistently about 0.20 millimeters longer than those of the Italians in group 1.

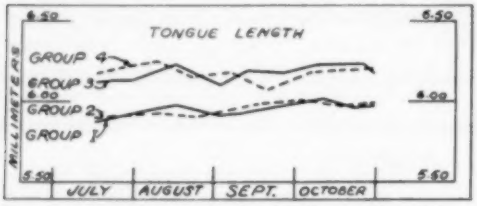

FIG. 1.—Average tongue length in samples of bees reared from the four groups of eggs.

There was no tendency for groups 2 and 4 to be intermediate between groups 3 and 1, although Alpatov (1929) reported Mikhailoff (1928) as having found such a tendency, using apparently only one set of samples. Instead, groups 2 and 4 closely followed the trend of their respective parent colonies.

SEASONAL TREND IN SIZE OF TONGUE AND WING.—To find the seasonal trend in size, if such existed, samples of about 100 young bees from the combs of these two colonies were taken at frequent intervals during the brood-rearing season. Measurements of wing length and wing width were taken, in addition to those of tongue length. Wing length was determined by measuring the right front wing from its base to its apex. Wing width was

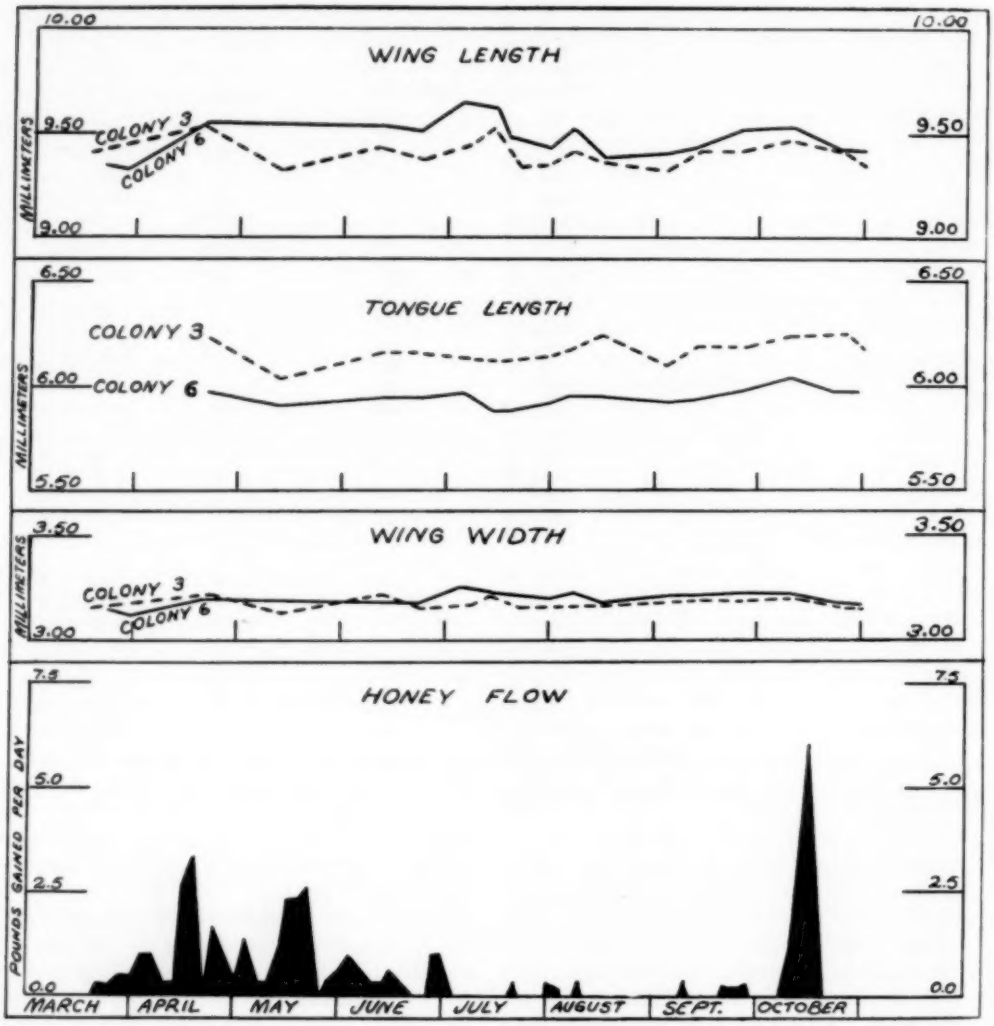

FIG. 2.—Average wing length, tongue length and wing width in the samples taken throughout the brood-rearing season from colony 3 and colony 6. The honey flow for the same period is also included.

determined by measuring the distance from the costal margin to the anal angle through the junction of veins R_3 with R_4 and of M_2 with cross-vein m-m.

These data are summarized graphically in fig. 2. They show that the size of the tongue was fairly constant throughout the season. The differences in wing length and wing width between the two colonies were not so pronounced as in tongue length. Certain simultaneous variations were especially noticeable in the wing-length curves. Colony 6 had longer and slightly wider wings than colony 3.

EFFECT OF HONEY FLOW ON TONGUE LENGTH.—To show the effect of honey flow, the weight record of a hive of bees on scales in the apiary is also graphically presented in fig. 2. The relation between length of tongue and honey flow indicated by Root (1901) is not shown, for the tongue length remained relatively constant regardless of the honey flow.

CONCLUSION—These observations, although only on two strains, indicate that nurse bees exert no abnormal influence on the development of their charges, so far as this could be determined from a study of the two heritable characteristics, tongue length and wing length. In other words, colonies from one strain of bees are probably as good as those from another for use as cell-finishing colonies, as far as the normal development of these two characteristics is concerned.

SUMMARY.—Eggs from one normal bee colony placed for development in another normal colony having different tongue lengths developed into adult bees identical with their sister bees as regards this anatomical characteristic.

Measurements of both tongue length and wing length indicated that the appendages seemed to retain the same general size throughout the season.

Honey flow did not seem to affect the size of tongue and wing.

Certain minor variations occurred simultaneously in the two colonies, which indicated that some unknown, probably external, factor affected their development.—1-10-38.

LITERATURE CITED

Alpatov, W. W. 1929. Biometrical studies on variations and races of the honey bee (*Apis mellifera* L.). Quart. Rev. Biol. **4**(1):1–58. Illus. March.

Mikhailoff, A. S. 1928. Effect of the colony upon the bees reared in it. [In Russian.] Opitnaya Paseka, no. **7**: 299–302. July.

Root, E. R. 1901. Our method of measuring illustrated; some interesting observations. (Editorial.) Gleanings Bee Cult. **29**(11):477–8. June.

Observations on Resistance of Some Dark Races of Honeybees to European Foulbrood

C. E. BURNSIDE, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

The resistance of the Caucasian and the Carniolan races of the honeybee, *Apis mellifera* L., to European foulbrood has never been conclusively investigated in this country. Perhaps the discovery, some 30 years ago, that the Italian bee is markedly superior to the common black bee in fighting the disease, coupled with the fact that the Italian bee was readily available, may account for this neglect in investigating the other two races. Many may also have reasoned that since the Caucasian and Carniolan bees resemble the common black bee in being dark colored, they are probably equally susceptible to European foulbrood.

During the past few years a few enthusiastic individuals have been advocating a wider use of the Caucasian and Carniolan races on grounds other than those of disease resistance. A report of some recent work by the Bureau of Entomology and Plant Quarantine on the resistance of these and the common black bees to European foulbrood may prove of interest, therefore, although only limited data of a preliminary nature have been accumulated.

METHODS.—The studies to be reported were conducted at Beltsville, Md., for the past three seasons, with stock obtained in this country. Queens from only one

queen rearer were used for each race, and not more than four colonies of a race were tested in any one season. The total number of queens used was 11 Caucasian, 10 Carniolan and 10 common black. None of the queens was retained in the experiments more than one year.

The advantage of using the common black bee as a comparative check in these experiments, rather than the Italian bee, is obvious, since a bee highly susceptible to European foulbrood will counteract better than will a highly resistant one any masking effect on the spread of the disease that might be caused by nectar flows or feeding.

The actual honey flows at Beltsville during the experiments were light, and at times it was necessary to feed the colonies to maintain sufficient stores. The same quantity of sugar sirup was given each colony.

Colonies were inoculated by spraying about 40 cubic centimeters of an inoculum over approximately equal amounts of their young and hatching brood. The inoculum was prepared by thoroughly macerating sick and recently dead larvae in water and straining through cheesecloth. More water was added until the final suspension contained one macerated larva in 5 cubic centimeters.

The strain of European foulbrood used in 1935 was obtained from a common black colony inoculated in 1934 with an inoculum prepared from a sample of diseased brood from Maine. In 1936 the inoculum was prepared by mixing two samples from Tennessee and one from Virginia. In 1937 it came from a colony of black bees in which the disease recurred that year after the colony had been used in the experiments for 1936.

In 1935 and 1936, during the week preceding the inoculations, the experimental colonies were equalized to cover eight or nine combs. In 1937 the Caucasian and Carniolan colonies varied in strength, covering from five to eight combs, although at the beginning of the experiments the black colonies covered about two frames more.

RESULTS WITH CAUCASIAN BEES.—On June 24, 1935, three Caucasian colonies were inoculated. Four days later approximately 40 per cent of the inoculated brood of a susceptible age had been affected. While there were many dead larvae in the inoculated combs, many of the cells that had contained young brood were empty, indicating that the colonies were already active in removing affected larvae. On July 5 disease was mildly active in the uninoculated combs, but the infection had decreased to about 10 per cent in the inoculated combs. Within three weeks after the original inoculation only a few scattered affected larvae were found, and by September the colonies appeared to be free from disease. There was no recurrence of the disease the following spring.

In 1936 four colonies of Caucasian bees were inoculated on June 25. Four days later about 25 per cent of the inoculated brood of a susceptible age in each of the colonies was affected, but 12 days after the inoculations were made neither sick nor dead larvae were found in any of the colonies. All four colonies have since remained free from European foulbrood.

In 1937 three Caucasian colonies and one colony with a purely mated Caucasian queen, but with bees thought to be Caucasian-black hybrids, were inoculated on June 3. In each colony fully 40 per cent of the inoculated brood of a susceptible age was found affected five days later, but the pure Caucasian bees seemed more actively engaged in removing affected larvae than were the hybrid bees. By the middle of June the pure Caucasian colonies appeared to have very few diseased larvae and had completely recovered by the end of the month. Disease continued very active in the hybrid colony until the first week of July; it then receded, and on July 30 only a few dry scales were found. None of the four colonies showed signs of disease during the remainder of the season. It is of interest to note that recovery in the hybrid colony coincided with replacement of its hybrid bees by pure Caucasians during a period when practically no nectar was available in the field.

RESULTS WITH CARNIOLAN BEES.—In 1935 two Carniolan colonies were inoculated on June 24. Their story is largely the same as that already given for the Caucasian colonies used in the same year.

In 1936 four Carniolan colonies were inoculated on June 25. Four days later about 25 per cent of the inoculated brood of a susceptible age in each was found affected. One recovered within 12 days after being inoculated, and the others recovered before the end of July. They all

remained free from disease for the remainder of the season.

In 1937 four Carniolan colonies were inoculated on July 30 with freshly prepared inoculum. Four days later about 40 per cent of the inoculated brood of susceptible age had been attacked, but the bees were very active in removing the affected larvae. Within 11 days after the inoculation only a few scattered dead larvae were found, and within 31 days the colonies were entirely free from diseased brood and remained so for the season.

RESULTS WITH COMMON BLACK BEES.—Two colonies of black bees were inoculated on June 24, 1935. Whereas four days later the degree of infection in each was about the same as in the Caucasian and Carniolan colonies, the infection in one colony remained heavy on succeeding examinations until nearly the close of the brood-rearing season although in the other colony it remained only slightly active throughout the same period. The worst affected colony was very weak when winter began, and died before spring. The other colony superseded its queen early in August, and its new queen evidently mated with an Italian drone because fully half her worker bees had one or more yellow bands. This colony survived the winter and remained free from disease in 1936.

In 1936 four colonies of common black bees were inoculated on June 25. Although practically the same amount of disease seemed present at first as in the Caucasian and Carniolan colonies, the disease remained fairly active in all four colonies throughout the season until October. It then subsided with the seasonal restriction of the brood nest. At the close of brood rearing the black colonies were, on the whole, considerably weaker than either Caucasian or Carniolan colonies.

Four black colonies were used in 1937. They were inoculated on June 10 with inoculum from the suspension prepared on June 3 for use on the Caucasian colonies. In the meantime this inoculum had been stored in a refrigerator at 40 degrees C. About 20 per cent of the inoculated brood of a susceptible age was dead within four days and, furthermore, most of this dead brood was still in the combs. In two colonies fully half the brood was dead within three weeks after the inoculation and nearly all the brood within seven weeks. The other two colonies were less heavily infected. Although from August on the infection slowly decreased in all four colonies, one colony died in September. By the middle of October disease had disappeared from the surviving colonies, but only one was of fair strength, whereas the other two were very weak.

SUMMARY AND CONCLUSIONS.—A study of the resistance to European foulbrood of 11 colonies headed by Caucasian queens and 10 colonies headed by Carniolan queens was made over a period of three seasons. Ten common black colonies were used as checks.

Each Caucasian and Carniolan colony contracted the disease upon being inoculated, but recovered by the end of the season without being seriously weakened.

The results for each season show little difference between the Caucasian and Carniolan bees, except in 1936, when the Caucasians recovered a few days sooner.

Most of the experimental black colonies were seriously weakened by the disease and two of them died. Disease remained active in each until late in autumn, and recurred the following spring in four out of five colonies that were wintered with their original queens.

While the work has been too limited to warrant drawing general conclusions, such results as have been obtained at least indicate that the Caucasian and Carniolan races are less seriously affected by European foulbrood than are common black bees.—1-10-38.

THE ALABAMA Commissioner of Agriculture and Industries on August 10 revised regulation 31 relating to certification of seed Irish potatoes and brought the requirements into conformity with the standardized regulations proposed by the special committee to the general conference of state officials and others, held at Louisiana State University, April 5–8. Two field inspections and one at shipping time are required, and maximum tolerances as to various diseases and insects are specified. The regulation further provides for the labeling as such of shipments of noncertified potatoes.

THE OKLAHOMA State Board of Agriculture on April 6 placed a standardized quarantine relating to peach mosaic in that and other infected states.

Vitamin E Content of Royal Jelly and Bee Bread*

MYKOLA H. HAYDAK and LEROY S. PALMER, *University of Minnesota, St. Paul*

Royal jelly is a glandular secretion of worker bees which is fed to the larvae of queen bees. It contains about 15 per cent fats. This food is supplied to the larvae in great abundance. Queen bees are characterized by an enormous production of eggs—up to 2000 in a single day during the peak of the season. Such a high fertility has aroused belief that royal jelly is rich in vitamin E.

Bee bread is pollen of plants (about 10 per cent fats) brought into the hive by bees and stored by them in cells of combs for further use. This pollen, moistened with nectar or honey in the process of handling, undergoes a lactic acid fermentation and thus is preserved undeteriorated in the cells. Pollen furnishes bees with the necessary elements for growth, maintenance and elaboration of larval food.

The vitamin E content of royal jelly and pollen has been studied by several workers. Hill & Burdett (1932) concluded that royal jelly contains vitamin E, but that pollen has none. However, they did not use a standard method of procedure for vitamin E assay, and the amounts of royal jelly fed to their rats was small (1.5 grams in a month period). Schoorl (1936) fed 0.05 grams of royal jelly daily to female rats during the gestation period. No evidence was obtained of the presence of vitamin E in the royal jelly. Mason & Melampy (1936) offered various amounts (50 to 1000 milligrams) of royal jelly to vitamin E deficient rats during the period of pregnancy. These amounts did not permit the completion of gestation in different female rats. Recently, Evans, Emerson & Eckert (1937), using standard procedure, fed up to 10 grams of royal jelly or equivalent of an ether extract to vitamin E deficient rats. No evidence was obtained of the the presence of vitamin E. Five grams of pollen fed to vitamin E deficient rats also gave negative results.

METHOD OF INVESTIGATION.—Royal jelly was secured from swarm queen cells during the summer of 1936. Bee bread collected and stored by bees in the season of 1936 was removed from the cells of combs. Both foods were kept in tightly covered jars and preserved in a refrigerator.

Rats for the experiment were prepared according to the technique already described (Palmer 1937). Five female rats were used for the assay of the royal jelly and 13 rats for the assay of the bee bread.

The royal jelly was fed as follows: On each of the first five days after impregnation, each rat received a mixture of four grams of royal jelly and five grams of the fat free basal ration. The mixture was moistened with tap water in order to keep it soft, because it had a tendency to harden. When it was necessary, this procedure was repeated one or twice a day. The rats consumed the day's ration completely and ate it eagerly.

The bee bread was fed after it was thoroughly mixed in a mortar with the fat free basal ration in ratio 1:1 or 2:1. These mixtures were given to rats *ad libitum* during the first five days after a successful insemination, and the food consumption of each rat recorded. Thus, the bee bread consumed by each rat was known in most cases.

RESULTS and DISCUSSION.—The results of the experiment are presented in table 1.

It is evident that 20 grams of royal jelly given during the first five days of gestation failed to supply sufficient vitamin E. Two rats fed bee bread were able to carry one living embryo to parturition. Seven other rats fed bee bread showed complete resorption and one rat had several partly resorbed embryos. Three rats fed bee bread had false pregnancy.

SUMMARY AND CONCLUSIONS.—Royal jelly fed to five vitamin E deficient pregnant female rats in amounts as high as 20 grams per rat during the first five days of gestation failed to prevent complete resorption of embryos.

Bee bread was consumed by vitamin E deficient female rats in amounts of 25 to 37.5 grams each during the first five days of gestation. In 2 cases out of 10 pregnancies, one living embryo was found at the end of gestation. Seven rats showed complete resorption, and in one rat at parturi-

* Paper No. 1583 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station. Completion of this project was made possible by co-workers supplied on project 1985, Minnesota Works Progress Administration. Sponsor, University of Minnesota.

Table 1.—Results of the experiment on vitamin E content of royal jelly and bee bread.

RAT NUMBER	FOOD	CONSUMPTION IN GRAMS	RESULTS
1	Royal jelly	20.0	6 implantations; completely resorbed
2	Royal jelly	20.0	5 implantations; completely resorbed
12	Royal jelly	20.0	8 implantations; completely resorbed
13	Royal jelly	20.0	3 implantations; completely resorbed
16	Royal jelly	20.0	7 implantations; completely resorbed
3	Bee bread	25.0	10 implantations. One not resorbed but dead; three almost resorbed; 6 completely resorbed
4	Bee bread	25.0	3 implantations; one embryo alive; two completely resorbed
5	Bee bread	25.0	False pregnancy
6	Bee bread	25.0	7 implantations; completely resorbed
7	Bee bread	35.6	5 implantations; completely resorbed
8	Bee bread	? wasteful	10 implantations; completely resorbed
9	Bee bread	31.8	7 implantations; gave birth to 1 live embryo, 2 underdeveloped embryos; 4 completely resorbed
10	Bee bread	30.0	10 implantations; completely resorbed
11	Bee bread	37.5	10 implantations; completely resorbed
14	Bee bread	31.8	8 implantations; completely resorbed
15	Bee bread	31.5	False pregnancy
17	Bee bread	24.0	6 implantations; completely resorbed
18	Bee bread	? wasteful	False pregnancy

tion, there was one recently dead embryo, several partly resorbed embryos and a number of complete resorptions.

The experiment indicates that royal jelly is probably devoid of vitamin E. However, this vitamin is present in bee bread, but in insignificant amounts.—1-12-38.

LITERATURE CITED

Evans, H. M., C. A. Emerson and J. E. Eckert. 1937. Alleged vitamin E content in royal jelly. JOUR. ECON. ENT. **30**: 642–6.

Hill, L., and E. F. Burdett. 1932. Fertility of bees and vitamin E. Nature **130**: 540.

Mason, K. E., and R. M. Melampy. 1936. Absence of vitamin E in the royal jelly of bees. Proc. Soc. Exp. Biol. and Med. **35**: 459–63.

Palmer, L. S. 1937. Biological assay of vitamin E. Ind. Eng. Chem. (analytical edition) **9**: 427–9.

Schoorl, P. 1936. Vitamin E research. Zeitschr. Vitaminforschung **5**: 246–53.

Dutch Elm Disease Eradication; Japanese Beetle Control; European Corn Borer and Gypsy Moth Certification

E. G. BREWER and WILLIAM MIDDLETON, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

PROGRESS IN DUTCH ELM DISEASE ERADICATION.—Pronounced decreases in the number of confirmations of Dutch elm disease infected trees during the 1937 foliar season, coincident with earlier and more intensive scouting, afford a basis for continued optimism in the general outlook for the work directed against this disease. It is hoped that the 25 per cent reduction in the 1937 confirmations, as compared to infections discovered in the summer of 1936, indicates a permanent improvement, and that, with uninterrupted efforts, progressive annual reductions may be expected.

During 1937, 6128 elms were confirmed as infected with the disease; 197 of these were found as a result of elm sanitation work performed prior to the summer scouting. From June 1, when scouts were placed in the field, until September 30, when yellowing of the leaves forced a discontinuance of scouting, scouts located 5497 trees which were later confirmed as infected. Of this total, 111 were in Connecticut, 4215 in New Jersey, 1136 in New York and 35 in other states. This is 1824 under the 7321 confirmations determined during the 1936 systematic scouting. The only increases were small num-

bers of trees in the Connecticut infected zone and at Indianapolis. New York netted a 33 per cent decrease and New Jersey a 23 per cent decrease, as compared with the previous year. Since elm sanitation work was resumed on October 1, 1937, an additional 434 confirmations have been reported. The grand total of infected elms found in the United States since the discovery of the disease in Ohio in 1931 is 27,971.

SCOUTING OPERATIONS.—At the peak of the scouting season the scout force totaled 3104, with 309 in Connecticut, 1830 in New Jersey and 965 in New York. Tentative quotas of scouts set for each state were not filled, owing to difficulties in securing WPA workers who were adapted to tree climbing, could identify elms and disease symptoms, and had other qualifications necessary for satisfactory performance as scouts. All men in sanitation crews with scout qualifications were given an opportunity to attend scout schools, and such as were found satisfactory for this type of work were transferred to scout crews.

Return of men on relief to private employment, dismissals for incompetence and cancellation of WPA workers' relief status made heavy inroads on the scout crews and necessitated the use of a lower grade of relief labor than in any previous scouting season. To offset this heavier load of inexperienced men, a larger number of trained tree workers were employed as crew foremen. The scouts were also required to give more detailed attention to elms showing any abnormal symptoms. This was particularly true in New York. Although this resulted in slower coverage of the areas, the intensified sampling lessened the risk of overlooking infected trees.

Closer attention to minor symptoms resulted in a large increase in the total of twig samples collected for dispatch to the laboratory. The record collection of the year amounted to 9417 samples for the week ending August 21. The season's total was 75,156 or a 34 per cent increase over the previous year.

Extensions of the infected zone necessitated by the discovery of diseased trees in the 10-mile protective zone surrounding the known infected area were limited to four small townships, all of which fall within lines connecting the outermost points of previously discovered infection. The newly added townships—in each of which single infected elms were confirmed—are Alexandria, Hunterdon County, N. J.; Cornwall, Orange County, N. Y.; and Redding and Weston, in Fairfield County, Conn. Each of these is contiguous to the infected area, and their addition to the zone may be made without including any intervening territory.

Increases in the work area in which field operations are conducted involved additions to the infected zone of 28 square miles in New Jersey, 29 in New York and 32 in Connecticut. The infected zone is still confined to an area within an approximate radius of 50 miles of New York City; it now totals 5222 square miles, 308 being in Connecticut, 2971 in New Jersey and 1943 in New York. The 10-mile protective zone circumscribing the infected area comprises 707 square miles in Connecticut, 867 in New Jersey, 675 in New York and 729 in Pennsylvania, a total of 2978 square miles. The entire zone of field operations totals 8200 square miles.

In extent, the three 1937 surveys of the work area slightly exceeded those of the previous year. The entire work area in Connecticut was covered twice, with a third coverage of the infected zone plus one-fifth of the protective area. In New Jersey the work area was completely scouted on the first go-over and was entirely covered a second time, except for a hundred square miles scattered in Hunterdon, Somerset and Warren counties. A third scouting in New Jersey was carried on in 1680 square miles scattered throughout the work area. Two hundred square miles in the vicinity of localized disease concentrations in six New Jersey counties received a fourth go-over. In the first survey in New York, scout crews covered the entire infected area and 25 per cent of the protective zone. The second go-over extended to 90 per cent of the infected area, while the third included approximately one-third of the known infected territory. About one-third of that portion of the protective zone which lies in Pennsylvania was scouted on foot, and the remainder was covered by an autogiro crew.

For the second consecutive year it was possible in 1937 to cite substantial decreases in the number of infected trees found in many areas previously heavily

infected. Confirmations on Staten Island have decreased from 653 in 1934 to 326 in 1935, 70 in 1936 and 22 this year. Similar conditions were found in the Bronx, New York City, where successive years' confirmations of 453, 334 and 185 were this year reduced to 80. In Caldwell Township, Essex County, N. J., one of the most heavily infected areas in the state, confirmations declined from 398 in 1935 to 41 in 1936 and 9 in 1937.

Cooperation previously received from the Civilian Conservation Corps diminished as the 1937 season progressed, and finally, on September 30, was withdrawn entirely.

Scouting of isolated infections was directed from field stations established in Baltimore, Md., and Indianapolis, Ind. Activities outside the major infected area resulted in securing five confirmations near Wileys Ford, W. Va., a single diseased tree at Athens, Ohio, and 32 additional confirmations in the Indianapolis area. Scouts covering territory surrounding the locality where a single diseased tree was found near Cumberland, Md., in 1936, discovered the five infected trees near Wileys Ford. One of these was close to the Cumberland tree. Three more were closely clustered at a distance of three miles from the Cumberland infection, while the fifth was found six miles farther west. The diseased tree in Athens, Ohio, was found by a crew that was scouting on foot along railroads running through an area found infested with *Scolytus multistriatus* Marsham last year in a partial survey of the Ohio River and some of its tributaries. The Athens tree was located on the bank of the Little Hocking River, near the Baltimore and Ohio Railroad. *S. multistriatus* had emerged from this tree. About half of the crown had died in 1936, and discoloration was found in the last three annual rings.

Only negative results were secured by scouts in Baltimore, Brunswick and Cumberland, Md.; Norfolk, Va.; and Cleveland, Ohio, where infestations had been eradicated in previous years. Negative results of the 1937 summer's scouting in Cleveland were particularly gratifying, since they confirmed for the second year the effectiveness of the sanitation program in that city during the winter of 1935–36.

Cooperative scouting work in Indianapolis in 1937 was more efficiently supervised and more adequately manned than in any previous year. All scouting and eradication work in the Middle West is directed from that city. Activities in Indianapolis in 1937 were intensified under the direction of a pathologist transferred to that point from the field headquarters early in June. The handicap occasioned by employing untrained WPA scouts in previous years was in a large measure overcome this year by the assignment of experienced tree men to serve as foremen of the scout crews operating in the city. In addition to the systematic scouting in Indianapolis and vicinity, an autogiro unit spent most of September scouting the suburban areas surrounding the city for some distance.

Owing to the purchase of two additional autogiros this year, the autogiro scouting units now consist of four serviceable giros, with accompanying pilots, observers and ground crews. Between May 21 and August 24 one giro unit scouted 11,000 miles of railroad rights-of-way over which imported burl elm logs had been carried from ports of entry to midwestern veneer mills. The three remaining giro crews performed special scouting, largely confined to mountainous sections of the protective zone that are difficult to scout afoot. One spent most of the season in Orange, Rockland, Dutchess and Putnam Counties and a portion of Westchester County, N. Y., and a small section in the Connecticut protective zone. Two operated in the western strip of protective area bordering the Delaware River in New Jersey and Pennsylvania.

ELM SANITATION ACTIVITIES.—Prior to the 1937 activities, 21,843 infected trees had been discovered and eradicated. Sanitation work had accounted for the removal of 1,721,612 elms, and an additional 614,717 dead or more than half dead trees had been tagged for future removal. Crews working in swamp and mountainous areas to be made elm-free had destroyed 534,524 elms, and 11,948 elms in special control areas had been pruned.

Good production records have been established this year by sanitation and clear-cutting crews. These crews have removed 558,063 dead and dying trees, destroyed an additional 797,625 elms in clear-cutting sections and pruned 11,868 trees surrounding isolated infections.

Special elm sanitation projects are under way at the three isolated infections. At Athens, Ohio, two crews are engaged in removing worthless elms within a mile of the infected tree, and dead and devitalized trees will be removed within a larger radius. All elms in the vicinity of the confirmed trees at Wileys Ford, W. Va., are being pruned and sampled, and 92 men have been assigned to winter sanitation work in Indianapolis.

TREE MEDICATION WORK.—In 1936 work was started to treat chemically elms of extremely low value so as to bring about their death and prevent infestation by bark beetles. This work was started late in the fall and continued until spring. Over 650,000 trees were treated and for the most part they were concentrated in swamp and other areas which are difficult to scout because of the nature of the land.

Owing to differences in operating conditions, the method of applying the chemical treatment varied somewhat during the course of the work. A dry copper sulphate pack under the bark of the tree was the standard treatment. Mortality among the treated trees was excellent, but death in many instances was slower than expected. Applications of the dry chemical during the winter months did not result in uniformly satisfactory results in all trees treated. It was found that parts of a number of treated trees were infested by bark beetles. Accordingly, this treating method was discontinued for the winter of 1937–38 to avoid the possibility of building up a large population of bark beetle vectors, which might successfully infest trees that were not sufficiently protected by the poison treatment.

Further experimental work to improve this treatment is being carried on by this division and by the Division of Forest Insect Investigations at the Morristown, N. J., laboratory.

On the whole, the tree medication work of the winter of 1936–37 may be regarded as a distinct gain at the present time, owing to the reduction in the area to be scouted.

FEDERAL, STATE AND MUNICIPAL APPROPRIATIONS.—Federal activities on the project during the fiscal year beginning July 1, 1937, were financed by a regular departmental appropriation of $460,860. This was supplemented by several allotments of Works Progress Administration funds totaling $1,724,040 for field operations and $22,000 for administrative expenses. State appropriations and contributions toward the cooperative work amounted to $140,000 in New York, $41,580 in New Jersey and $25,000 as a biennial appropriation in Connecticut. The state of Indiana contributed the services of five experienced tree men for three months. The Department of Parks of the City of New York took care of removal of all dead and dying elms on city property. It is also estimated that approximately $30,000 will be expended by 55 municipalities in Connecticut in carrying out elm sanitation projects.

Close cooperation on a mutually satisfactory basis has continued with state officials.

JAPANESE BEETLE CONTROL OPERATIONS DURING 1937.—Japanese beetle scouting of 1937 was characterized by the apparent eradication of the insect in St. Louis, an unusual reduction in the Chicago infestation and the scarcity of first-record infestations of an established nature.

Unquestionably the one outstanding achievement of the year—climaxing annual control programs begun in 1934—was the suppression of the insect over an extensive area in St. Louis. Beetle collections in the city, starting with 1934, have totaled 1351, 1232 and 88. The trapping and treating program of 1937 was more efficiently operated and supervised than in any previous year, yet only 1 beetle was collected. In addition to the operation of 12,557 traps throughout the city, approximately 100 man-days of manual scouting for the insect were performed with negative results. A solitary female was trapped outside of the previously treated area in an enclosed court in the rear of a brick building and in an environment particularly unfavorable for larval survival. Nevertheless this yard and surrounding premises, to the extent of 2.7 acres, were treated with lead arsenate early in the season. State and city officials and the Works Progress Administration have cooperated with this Bureau in carrying out the control program.

As the spring and summer of 1937 progressed, 111,000 traps were set in 418 cities and towns in 25 states, scattered from Florida to Vermont, and westward as far as Denver. California authorities

also placed a few traps in Sacramento, Roseville and Los Angeles. Some trapping activities were conducted in all but 16 states outside of the present quarantined area.

TRAPPING IN SOUTHERN STATES.—Trapping began on April 21, 1937, in Florida, and trap placement gradually proceeded northward as the season advanced. Few first records of importance were discovered during this year's trapping in the south. Trapping in non-quarantined states south of the Mason-Dixon line extended to 5 cities in Florida, 6 in Georgia, 8 in South Carolina and 15 in North Carolina. All Florida trapping was with negative results. In Georgia positive results were obtained only in Atlanta. Catches in South Carolina were confined to two negligible infestations in Charleston and Greenville, where the captures were considerably lower than last year. The Greenville reduction may be attributed to soil treatment applied in the spring of 1936. In North Carolina, beetles in varying numbers were caught in all but 2 of the 15 known infested communities trapped. Beetles in considerable numbers were taken in Greensboro, Spencer, East Spencer and Winston-Salem, all of which are under a state quarantine paralleling the federal regulations. Small infestations were disclosed at nine other points. There was little change in the conditions of infestation from 1936.

TRAPPING IN SOUTH CENTRAL STATES.—Trapping was repeated in Lexington and Louisville, Ky., in 1937 with positive results; while negative results were obtained at Frankfort and Newport, Ky.; Bristol, Chattanooga, Knoxville and Nashville, Tenn.; Mobile, Ala.; and New Orleans, La.

ACTIVITIES IN NORTH CENTRAL STATES.—Traps were set in all North Central states, except the Dakotas and Minnesota. The numbers of cities and towns surveyed in the non-quarantined states were Indiana 12, Michigan 9, Illinois 13, Wisconsin 3, Missouri 14, and 1 each in Iowa, Nebraska and Kansas. All trapping in Wisconsin, Nebraska, Iowa and Kansas gave negative results.

There was still a further reduction in the Indianapolis infestation. Only 12 beetles were caught during the 1937 season, whereas previous annual catches since 1934 have been 17, 57 and 28. Early in April, 1937, soil treating was completed at the Indianapolis infestations. Seven of the 1937 collections were caught in the treated area and the remainder were trapped at scattered points outside. Treating was recently completed in the small acreage requiring treatment as a result of the 1937 season's collections in the city.

A first-record catch was made at Logansport, Ind., and some increases in trap captures occurred at Fort Wayne and South Bend. At Fort Wayne 39.5 acres were treated with lead arsenate, starting October 12. Approval of a state-sponsored WPA soil-treating project in South Bend is pending. Results in eight other Indiana communities were negative.

Lead arsenate applications in the fall of 1936 and the spring of 1937 at Detroit, Mich., reduced the number of trapped beetles from 128 to 67. Further soil treatments, covering 39.7 acres of newly infested area, were made during October. In addition, 10.9 acres in Dearborn were treated. No other positive trapping results were obtained in Michigan.

Control work in Chicago resulted in an even speedier reduction of beetles in areas treated with lead arsenate than was obtained in St. Louis. In 1936, 3740 beetles were taken, while in 1937 the combination trapping and treating program yielded only 384. When the heavy infestation was discovered in 1936 near Bessemer Park in southeastern Chicago, 3637 beetles were trapped in 72 contiguous blocks, a single block accounting for 1101 of these, and 37 beetles were collected in 30 scattered blocks. Additional infestations found last year consisted of 55 beetles near the Chicago Produce Terminal, 5 beetles near the freight terminals of a number of railroads, 4 in the northwestern section of the city and two single finds in the Marquette Park section. Shortly after discovery of the heavy infestation, a state-federal treating program was inaugurated. Field treatments extended from August 24 to November 16, 1936, while some of the treatments were completed in the spring of 1937 from May 6 to June 11. A total of 129 acres was treated at the regular dosage, and excellent control was obtained from the fall treatments. In the most heavily infested block, trap captures were reduced from 1101 to 2 beetles, and there was a 93.5

per cent reduction—from 3674 to 242—throughout the Bessemer Park section. A substantial emergency state appropriation was made available for further soil treatments in Chicago. Approximately 50 acres outside the previously treated areas in Chicago received lead arsenate applications in the fall of 1937.

With the exception of several other captures of beetles in small numbers, the results in Illinois were negative.

Negative results were secured from traps in 13 Missouri cities, and the lone beetle in St. Louis was the only capture in the entire state in 1937. Federal traps set and tended by state employees in Denver and Pueblo, Colo., and Sacramento and Roseville, Calif., also failed to yield beetles.

TRAPPING IN PARTIALLY REGULATED STATES.—Eighteen West Virginia communities were trapped in 1937, nine of them with negative results. Three first-record trap collections were reported by the assistant state entomologist, who supervised the trapping activities throughout the state. Trap catches indicate that beetles persisted in negligible numbers at other points where trapping has been done in previous years.

In Virginia, traps were operated in 1937 in 84 communities. Catches were made in 13 cities and towns. Three first-record finds in Virginia in 1937 were limited to a single beetle each. On the George Washington Birthplace National Monument at Wakefield a heavy, but apparently localized, first-record infestation was reported by the National Park Service. Trapping and scouting were concentrated in that area. Later, approximately 12 acres were treated by the National Park Service, under the supervision of this Bureau. Beetles were caught again in 1937 at nine previously discovered Virginia infestations, and definite arrangements were made for the application of lead arsenate early in the spring of 1938 to from six to eight acres surrounding the principal infestations in Charlottesville.

In 1937, 92 cities and towns were trapped in Maryland. Seventy-three were trapped with negative results. First records were obtained at 10 places, and carry-over infestations were determined at 9 places, at 4 of which the captures indicate an increase in population. Three small infestations were discovered by nursery and greenhouse scouts in sections just outside the regulated area in Carrol and Talbot counties.

First-record trap finds were made at six points in Ohio, and isolated infestations discovered in previous years were found to have persisted at six additional places. At Marietta, where delayed treatments of lead arsenate were applied in the spring of 1937, collections declined from 121 to 45. Trapping in 38 other Ohio communities was with negative results.

Although nonregulated territory in New York was thoroughly trapped, only one first-record infestation was disclosed, while captures indicating persistence of infestations were made at six localities. In Rochester and Watkins Glen the infestations of previous years increased considerably. Traps were operated in 25 cities with negative results.

In Pennsylvania the Erie infestation of 1937 about tripled the finds of 1936. Approximately 100 of the 149 beetles trapped there in 1937 were taken in a block adjacent to an area included in the 19.5 acres which received chemical treatment during April of 1937. Only one first-record capture was reported, while small numbers of beetles were captured in two locations from which they had been previously recorded. Negative results were obtained in 10 other cities of northwestern Pennsylvania.

Although traps were set in 25 communities throughout the nonregulated section of Vermont, no beetles were caught.

QUARANTINE ENFORCEMENT.—Imposition of stricter fumigation and loading requirements on the movement of refrigerator cars containing fruits and vegetables from the heavily infested areas of New Jersey, Pennsylvania, Delaware and Maryland resulted in the transportation in 1937 of fewer living beetles in the bunkers of these cars than in 1936. Examination of hundreds of refrigerator cars upon their arrival at midwestern terminals from eastern points resulted in the finding of 32 living beetles distributed among 20 cars. Nineteen of these infested cars were from the eastern shores of Maryland and Virginia, and one was from southeastern Pennsylvania. During the heavy flight of 1936 the transit inspectors making similar inspections recovered 97 living beetles from 70 cars.

Continued laboratory experiments on

the use of paradichlorobenzene for the fumigation of potted plants demonstrated the effectiveness of this material in the treatment for certification purposes of small azaleas and a limited number of perennials. Recently revised treating instructions now authorize this new type of fumigation.

Procedure for the scouting of nurseries classified under the Japanese beetle quarantine regulations was modified during the summer of 1937 to permit the rescouting of certain establishments located in sparsely infested sections, on which one or a few beetles had been found during the previous summer's scoutings. A number of establishments reverted to a preferred status of classification after periodic summer scouting had failed to disclose any infestation on or in the vicinity of the nurseries.

EUROPEAN CORN BORER CERTIFICATION.—Inspection and certification service to conform to the requirements of state quarantines of Arizona, California, Colorado, Georgia, Louisiana, Nevada, Oregon, Texas and Utah continued in 1937 as previously organized. The bulk of the inspection work was performed by men engaged in both Japanese beetle and European corn borer inspection, and in New England area in gypsy moth certification as well.

During the fiscal year 1936–37, 19,784 certificates were issued to cover quarantined plant material, principally dahlia tubers, valued at $209,050.

CERTIFICATION OF PRODUCTS UNDER GYPSY MOTH QUARANTINE.—Enforcement of the gypsy moth quarantine regulations continued in 1937 as previously. There were no developments requiring revision of existing quarantine regulations, and during the fiscal year 1936–37, inspectors destroyed 1257 egg clusters, 235 larvae and 136 pupae, all taken from material destined to nonregulated points. —1-11-38.

Grasshopper Outbreaks in Iowa*

C. J. DRAKE and G. C. DECKER, *Iowa State College, Ames*

A cursory examination of the history of Iowa may lead to the erroneous conclusion that grasshoppers first appeared in devastating numbers in the state about 1866 and that from about 1890 up to the beginning of the present epidemic outbreak in 1931, they have been of very little importance. A thorough search of farm periodicals, newspapers, reports of horticultural and agricultural societies, entomological literature and records of adjoining states soon leads to the realization that grasshoppers undoubtedly had a very wide distribution and, moreover, were intermittent pests of great importance long before the white settlers began to disturb the sod of the virgin prairies.

EARLY OUTBREAKS OF ROCKY MOUNTAIN GRASSHOPPER.—In enumerating the animals of the northwest, Jonathan Carver (1838), who in 1766 had journeyed across southern Wisconsin and into northeastern Iowa and Minnesota, wrote, "I must not omit that the locust is a septennial insect, as they are only seen, a small number of stragglers excepted, every seven years, when they infest these parts and the interior colonies in large swarms and do a great deal of mischief."

Lugger of Minnesota (1897) recorded an old Indian tradition that grasshoppers once took possession of the country, holding it for a period of 17 years. Neill (1882) in his history of Minnesota reported a locust invasion in the Red River area in 1818 and 1819. Riley (1877) stated that a similar invasion had occurred in western Missouri about 1820. Although no definite records have been found, it seems probable that western Iowa, which was at that time only very sparsely settled, suffered from the locust invasions of 1818–1820.

In the first report of the United States Entomological Commission (Packard 1878) an Indian chief, Johnny Green, is credited with the report that the grasshoppers in west central Iowa were so thick in 1833 that the grass had all been eaten off by the 'hoppers and that no pasture was left for the Indians' ponies. The same volume quotes a letter from

* Journal paper No. J321 of the Iowa Agricultural Experiment Station, Ames; project No. 372.

A. H. Gleason of Little Sioux, Iowa, who observed large flights of grasshoppers in August, 1856, and the subsequent hatching of great numbers of nymphs in the spring of 1857. A Mr. Whitman is also credited with the statement that the locust flights reached as far as central Iowa in 1857. The two latter observations are supported by other published records.

From 1864 until 1879 there was hardly a year in which the grasshoppers or locusts, as they were called, did not appear in devastating numbers at one or more points in the state. The years 1867-68 and 1873–77, however, are generally regarded as the periods of greatest locust damage in Iowa. Time and space will not permit repetition or even enumeration of the many reports of the mass flights of mighty hordes of 'hoppers which darkened the sun by their numbers, invaded large areas of the state, quickly devastated field and garden crops and stripped trees and shrubs, leaving nothing but ruin and destitution in their wake.

The invasion in 1873 so completely destroyed crops in northwest Iowa that the state legislature meeting early in 1874 appropriated $50,000 to buy seeds for the farmers in the stricken area so that they might remain on their farms the following year. Because of the grasshopper devastation year after year and "apparent" hopeless situation in western and northwestern Iowa, many settlers abandoned their farms for a mere pittance and either returned east to their former homes or sought other locations in the Far West.

The foregoing locust invasions are invariably attributed to the Rocky Mountain grasshopper, *Melanoplus spretus* Walsh; yet, it is probable that this insect was most ably assisted in its depredations by other species of grasshoppers, which have demonstrated their great ability to destroy vast acres of crops in recent years. The Rocky Mountain grasshopper is now generally treated as the swarming or migratory phase of *M. mexicanus* (Saus.) and is listed as *M. mexicanus spretus* (Walsh). Some evidence of the reappearance of the typical *spretus* has been reported during the present outbreak.

EARLY OUTBREAKS OF OTHER COMMON GRASSHOPPERS.—The early history of the common grasshoppers, *M. femur-rubrum* (De G.), *M. differentialis* (Thos.), *M. bivittatus* (Say) and *M. mexicanus* (Saus.), is extremely incomplete, due to the absence of competent observers and to the fact that these species were often confused with the Rocky Mountain grasshopper. It is especially worthy of note that Riley, Walsh, Bessey, Bruner, Osborn and other pioneer Mid-Western entomologists from their initial writings almost invariably separated *M. femur-rubrum*, *M. differentialis* and *Dissosteira carolina* (L.) from the Rocky Mountain grasshoppers. In commenting on a report that grasshoppers destroyed a corn field near Council Bluffs in the summer of 1850, Packard (1878) says, "The species may have been, and probably was, *M. femur-rubrum*, the common red-legged locust."

Grasshoppers were more or less abundant in central and eastern Iowa in 1867 and 1868. Walsh & Riley (1868) quoted a letter from Judge Grant of Davenport, Iowa, stating, "On the 25th and 30th of June, I cut a 10-acre clover field on my farm on Duck Creek; just then the 'hoppers were hatching; before the new buds had grown they attacked them and destroyed the 10 acres; and they are at present working in a field of 10 acres which was cut the 19th of June and is now in bloom." In the same article the authors referred to the situation just across the river in Illinois as follows: "The grasshoppers, in 1868, are at least four or five times as numerous, near Rock Island, Ill., as they have ever been known to be; and they are eating there almost everything that is green. They consist in nearly equal numbers of three species common in that region, *Caloptenus femur-rubrum* De Geer, *Aedipoda carolina* Linn., and *Caloptenus differentialis* Uhler, MS. Near Chicago the last species seems to be replaced by *Caloptenus bivittatus* Say. Not a specimen of the Hateful grasshopper from the Rocky Mountains (*Cal. spretus* Uhler, Walsh) is to be met with among them."

Prior to the "locust invasions" of 1873–74 the non-migratory species again became unusually abundant. In commenting on the situation at that time, Bessey (1877) referred to *M. differentialis* (Thos.) thus, "It is unfortunate for us that there is no good common name for this species, as it is the most destructive native locust we have. . . . In the year 1873, and for a year or two previous to that date, this species was so abundant on the college farm as to do a good deal

of injury; since then it has been less abundant." Professor McAfee (1875) referring to the situation on the college farm at Ames said, "1874 was preeminently a locust year and all crops suffered by their greed. The hateful locust of Colorado did little damage, but the allied species were very destructive, per contra, in 1875 but few locusts occupied our grounds."

In some local areas the differential grasshopper was abundant in 1883, when Osborn (1883) reported large numbers of this insect dying from a fungous disease. In the crop and weather digest of the Iowa Agricultural Report for 1885 more than 20 references to crop damage are cited in the county reports. The situation is summarized by the Secretary of the Iowa Agricultural Society, John R. Schaffer (1886), as follows: "Reports came from various and widely separated parts of the state of the injuries to the crops from grasshoppers especially during August and September. The most numerous of the varieties was identified by Prof. C. V. Riley as the *Acridium femur-rubrum* or red legged locust. . . . About the same date (July 31) they so denuded certain portions of Louisa County of its grass, as to compel the removal of cattle to other pastures. They had not been so plentiful in a generation. . . . They ate the silk from the ears of corn, stripped young orchards of their leaves, cut off bunches of grapes, not eating at them, but letting them fall to the ground. . . . On September 4th they were almost entirely destroyed by flooding rains and the accompanying reduction of temperature in southeastern Iowa."

The grasshoppers apparently hatched in large numbers in some counties in 1886 and vanished before doing much serious damage to cultivated plants. In the spring of 1887 they were again reported as hatching in great numbers in Adair, Adams, Black Hawk, Calhoun, Clarke, Henry, Lee, Ringgold, Van Buren, Warren and Wayne counties but little damage was done by them that year. In 1888 the 'hoppers must have been rather scarce for as one horticulturist stated, "Turkeys wandered two or three miles from home in quest of hoppers."

To quote from Osborn & Gossard (1891): "The recent rumors regarding the probable invasions of the Rocky Mountain Grasshopper and the actual abundance of our native species this season will make some items on the subject timely. . . . " In another article, Osborn (1891) stated, " . . . the young grasshoppers will be observed almost every season in great numbers from June till they get their growth in the fall and as they spring up on every hand, dozens of them on every square yard . . . these alone must regularly devour nearly or quite as much grass as the cattle ordinarily pastured on the same land." Records indicate that grasshoppers were not particularly destructive but remain threatening until their numbers were greatly reduced during the wet summer of 1896.

LATER OUTBREAKS.—*M. femur-rubrum* and *M. bivittatus* again appeared in destructive numbers in 1910 and the following year Webster (1911) reported considerable damage to corn, small grain, fruit trees and other crops. Correspondence in the college files and statements from the older farmers show that most of the state was involved in this outbreak and that damage was very severe. Some of the more common comments from the correspondents include such statements as, "They clipped all of my oats"; "I saved less than one-fourth of my grain"; and "The second cutting of clover was entirely stripped." Some farmers in Kossuth County described how the 'hoppers concentrated ahead of the binder, cut the heads off the oats and finally forced the farmers to abandon the fields.

After a few years of comparative scarcity, the grasshoppers again increased to threatening numbers in 1917 and the next year damage occurred in over half of the counties in the state. Jaques (1919) published a good account of conditions in 1918 and discussed the use of poison bran bait and 'hopper-dozers. Jaques also records collecting one to two bushels of 'hoppers per acre in 'hopper-dozers, and that one man collected and dried 1400 pounds of grasshoppers for chicken feed. The actual count of 1000 Orthoptera collected in a 'hopper-dozer at Salem, Iowa (533 *M. femur-rubrum*, 216 *M. differentialis*, 142 crickets and 109 miscellaneous 'hoppers) shows the importance of the two most destructive species in southern and eastern Iowa.

In 1919 and 1920 grasshoppers received scant attention, but in 1921 and 1922 they were very destructive in 10 or 12

southwestern counties. From the records at hand it appears that *M. bivittatus* and *M. femur-rubrum* were the dominant species, with *M. differentialis* rating third and *M. mexicanus* fourth in importance. The outbreak was short lived and its decline attributed to unfavorable weather conditions and an abundance of parasites, and predators. In the most heavily infested areas, farmers protected their crops by baiting with poisoned bran.

THE CURRENT OUTBREAK.—The current outbreak had its beginning in 1930, and considerable damage occurred in 1931 and 1932 in several counties bordering on the Missouri River. From 1933 to 1935 grasshopper populations fluctuated moderately, heavy local infestations here and there being held in fair check by the baiting operations, diseases, parasites and unfavorable weather. Throughout this period, however, the 'hoppers were gradually spreading and increasing in numbers in practically all parts of the state. The late wet spring of 1935 produced an abundance of vegetation and delayed hatching, but favorable biotic conditions the rest of the season permitted the 'hoppers to live long and deposit unusually large numbers of eggs, which set the stage for the serious outbreak during the dry spring and summer of 1936.

The spring and summer of 1936 were unusually hot and dry, vegetation was scant and hordes of young 'hoppers soon denuded fence rows, pastures and waste areas and congregated in cultivated crops. Small grain, corn, alfalfa, clover and pastures were severely damaged; orchards, shrubs, forest trees and nurseries suffered from their attack. The long continued drought, hot winds and the attendant shortage of succulent green food apparently shortened the life of the 'hoppers and greatly reduced the numbers of eggs deposited. Although the soil contained many egg pods in the fall, the total was by no means commensurate with the 'hopper population in midsummer.

The young hatched in great numbers in the spring of 1937 and nymphal populations of 200 to 500 or even over 1000 per square yard were not at all uncommon. Heavy and continued rains during the hatching period, fungous diseases, parasites and very extensive poisoning operations held the pests in check. In addition, the abundance of succulent vegetation in the pastures, fence rows and in other non-cultivated areas supported large populations of grasshoppers and greatly decreased the local shifting to cultivated crops as the season advanced. Furthermore, the abundance of wild vegetation, favorable weather conditions during the latter part of the summer and a very late fall were conducive to long life and maximum egg deposition. *M. mexicanus* practically completed two generations and many egg pods of this species as well as other destructive species were deposited in September, October and early November. Conditions could not have been much more favorable for maximum egg deposition. The results of the 1937 fall egg survey show rather conclusively the infestation to be more severe and more widespread than at any other time during the current outbreak.—1-8-38.

LITERATURE CITED

Bessey, C. E. 1877. A preliminary catalogue of the Orthoptera of Iowa. Seventh Bien. Rept. Iowa State College: 205–10.

Carver, Jonathan. 1838. Carver's Travels in Wisconsin. Third Ed. 376 pp. Harper and Bros., New York, N. Y.

Jaques, H. E. 1919. Grass-hopper control work in Iowa. Iowa Acad. Sci. **26**: 133–42.

Lugger, Otto. 1897. The Orthoptera of Minnesota. Minn. Ag. Exp. Sta. Bul. **55**. 386 pp., 187 figs. Dec.

McAfee, Henry H. 1875. Progress of the Department of Horticulture for the year 1874 and 1875. Sixth Bien. Rep. Iowa State College: 92–127.

Neill, Edward Duffield. 1882. The history of Minnesota. Fourth Ed., 966 pp. Minn. His. Co., Minneapolis, Minn.

Osborn, Herbert. 1883. An epidemic disease of *Caloptenus differentialis*. Amer. Nat. **17**: 1286–7. Dec.

Osborn, Herbert. 1891. Some insects destructive to grass. Iowa Ag. Exp. Sta. Bul. **13**: 95–115. May.

Osborn, Herbert, and H. A. Gossard. 1891. Reports of Entomological Work. Iowa Ag. Exp. Sta. Bul. **14**: 166–80.

Packard, Jr., A. S. 1878. Chronological history. First Rept. U. S. Ent. Comm., 53–114.

Riley, C. V. 1877. The locust plague in the United States. 236 pp., Rand McNally and Co., Chicago.

Shaffer, John R. 1886. Secretary's report. Iowa State Ag. Soc. Rep. 1885. 5–57.

Walsh, B. J., and C. V. Riley. 1868. Grasshoppers. The Amer. Ent. **1**: 16. Sept.

Webster, R. L. 1911. Insects of the year 1911 in Iowa. JOUR. ECON. ENT. **4**(6): 524–7. Dec.

Gypsy Moth and Brown-Tail Moth Control Operations During 1937

A. F. Burgess, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

Suppression and control work on both the gypsy moth, *Porthetria dispar* (L.), and brown-tail moth, *Nygmia phaeorrhoea* (Donov.), was carried on during the fiscal year which ended June 30, 1937, through regular funds supplemented by WPA allotments of $2,026,000 for the gypsy moth and $477,699 for the brown-tail moth. The number of men on these projects throughout the year averaged 2492 for the gypsy moth, with a maximum of 3571, and 1034 for the brown-tail moth, with a maximum of 1359. Ninety-six per cent of these workers were taken from relief rolls and all supervision was performed by regular Bureau employees. As in the past, the states concerned cooperated, furnishing supervision at times, as a result of which more work was accomplished than would have been possible otherwise.

Men detailed from CCC camps directed from the Bureau of Entomology and Plant Quarantine office at Greenfield, Mass., continued gypsy moth work directly east of the barrier zone, and some similar work was carried on by the New York State Conservation Department from CCC camps in New York. Work by all agencies—federal, state, and local—was so planned that duplication was avoided.

Equipment.—During the year 1937, considerable attention was given to improving machinery and equipment used in field work. Along this line was the development and adaptation of a machine for reducing brush and slash to sawdust in order to avoid fire risk. Spraying machines capable of developing 1500 pounds working presssure were secured, and these made it possible to spray areas as far as 12,000 feet from the point where the sprayer was set up. This long-distance spraying is often necessary in woodland work where water supplies are not close to the areas to be sprayed or where the topography is such that the machines cannot be moved close to infested sites.

Much attention was given to the elimination of favored gypsy moth food plants so that woodland areas will be less susceptible to attack. For some few areas, which have only small proportions of favored food, permanent protection is possible, but in others so much favored food exists that only partial protection can be accomplished, and thinning has to be supplemented by intensive control work.

Weather.—Mild weather, with little snow during the winter of 1936–37, made working conditions more favorable than usual, and this had a direct bearing on the amount of work accomplished. On the other hand, these same conditions were favorable for the gypsy moth, which suffered little mortality through natural causes. This was reflected in the defoliation recorded for 1937, as a greater acreage with from slight to complete defoliation was found than had ever before been recorded. The total for the infested area was 608,760 acres with defoliation. Very great increases in defoliation over the records for 1936 were recorded for Maine and Massachusetts. In New Hampshire there was less defoliation in 1937 than in 1936; and this was true, though to a lesser extent, in Rhode Island. For both Vermont and Connecticut only a small amount of defoliation was recorded. No defoliation was reported from New York, New Jersey or Pennsylvania.

During the month of June, when the major portion of spraying work for the gypsy moth is carried on, weather conditions were less favorable in 1937 than at any time for several years. There was considerable rain, which interrupted this type of work seriously and resulted in a great reduction in the acreage that normally would have been sprayed with the equipment available.

Areas Covered.—In the extreme eastern part of Washington County, Me., work was continued in the area found infested the previous year, and a slight infestation was found in four towns and on a few residential properties in Calais. Employees of the Entomological Branch of the Canadian Department of Agriculture examined territory in the Province of New Brunswick contiguous to the infested area in Maine and located small infestations on 15 properties. They planned further work for that section.

During the early part of the fiscal year special scouting work was performed in the extreme northern part of New Hampshire. No infestations were located. Additional work in this state was performed in towns bordering the Connecticut River.

Nearly all of the WPA work in Vermont, Massachusetts and Connecticut was carried on west of the Connecticut River. In the barrier-zone section of these three states no infestations were found in Vermont, and conditions were more satisfactory than for some time in Massachusetts; but in Connecticut, owing to shortage of relief labor there, work in the zone suffered, and conditions in that section are not so satisfactory as in the other two states. Between the zone and the Connecticut River considerable infestation exists in Vermont close to the river and in a number of towns in Massachusetts, but in the same sections of Connecticut it is not so heavy.

In New York considerable scouting was done within the zone area and in some counties to the west and south, largely by WPA forces. Infestations were discovered at Shawangunk, in Ulster County, by state employees, after an assembling cage had attracted male moths, and in Putnam Valley, Putnam County, by CCC camp men. Both of these infestations were reduced materially by intensive control work in which WPA forces assisted. Several small infestations were located and treated by CCC camp forces in the zone and in Westchester County, the Bronx, and in Nassau County on Long Island. Except for Shawangunk and Putnam Valley, the state of New York is in better condition as regards gypsy moth infestations than for several years past.

Special survey work to locate possible outlying infestations west of the Hudson River was continued, covering 488 townships and boroughs in 31 counties. No infestations were found.

WPA workers scouted intensively the last known infested area in New Jersey but found no infestation.

In the Pennsylvania area much scouting was done both within and just outside of the area of known infestation, together with about 100 miles of banks along the Lackawanna and Susquehanna rivers where infestation might have been spread by the flood waters of 1936. A few small infestations were found outside of the state quarantined area, but for the most part these were not dangerous. Wherever infestations were found there was intensive follow-up work. A number of sites infested in 1936 were found apparently free and, as excellent progress in extermination has been made, the situation looks more hopeful each year.

EXTENT OF WORK.—During the year WPA employees, supervised by the regularly appointed personnel, scouted, in New England, New York, New Jersey and Pennsylvania, over 1,300,000 acres of woodland, together with nearly 1,500,000 acres of open country and about 8,000,000 scattered trees, covering, during this work, some 11,000 miles of road. In the course of this work they destroyed 2,217,731 gypsy moth egg clusters. At infested sites, thinning work for the elimination of favored food plants was performed in over 7500 acres of woodland and, in addition, 4600 trees were cut in the open. During the larval season over 1,000,000 burlap bands were applied to trees at infestations and 1,321,244 gypsy moth larvae and pupae destroyed under them. For the purpose of excluding livestock from areas that were sprayed, over 500,000 feet of barbed wire were erected as fences. During the spraying season 13,215 acres of woodland were sprayed, together with 5766 residential properties and over 65,000 isolated trees in the open.

Work done by CCC camp personnel under the supervision of the Bureau was in infested sections east of the barrier zone for the protection of this zone. Owing to fluctuation in available personnel, and regulations as to work and travel, it was not possible to perform all work as planned; so some areas were left without attention, although it was needed badly. Cuts in personnel were drastic, as from a quota of 1465 juniors and 15 veterans at the beginning of the fiscal year the force was reduced to 733 juniors and 14 veterans by the end of June, 1937. Work of this nature was abandoned in New Hampshire, whereas in Vermont and Connecticut the abandonment of camps and reduction of personnel resulted in seriously infested areas being left without complete treatment. To a lesser extent the same situation applies to Massachusetts. At present the roster of camps is five in Ver-

mont, nine in Massachusetts and six in Connecticut.

In connection with camp work, an Emergency Conservation Work forester was assigned through the Forest Service to aid in combining gypsy moth thinning work with modern silvicultural practice. Much good was accomplished through the reduction of infestations east of the zone, lessening the danger of spread toward the west, but with the reduction in personnel through abandonment of camps or decrease in enrollment less work can be done, and the zone will get less protection.

CCC camp enrollees working in New Hampshire, Vermont, Massachusetts, Connecticut and New York, scouted over 800,000 acres of woodland together with over 600,000 acres of open country and nearly 7,000,000 scattered trees, covering some 4300 miles of road. They destroyed 5,990,971 gypsy moth egg masses. Thinning work for the elimination of favored food plants was performed by them in nearly 5000 acres of woodland, and they also cut over 4000 favored food plants in the open. At infested sites over 2,000,000 burlap bands were applied to trees. These were visited regularly, and a total of 17,477,982 gypsy moth larvae and pupae was destroyed under them. During the spraying season 2616 acres of woodland and 49,000 isolated trees in the open were sprayed by CCC camp forces in New York state.

GYPSY MOTH CONTROL WORK
JULY 1, 1936 – JUNE 30, 1937

SCOUTING					THINNING	
OPEN COUNTRY			WOODLAND	EGG CLUSTERS CREOSOTED	ACRES OF WOODLAND	TREES CUT IN OPEN
ACRES	MILES OF ROAD	SCATTERED TREES	ACRES			
2,119,423	15,570	15,071,509	2,163,490	5,990,702	12,447	9,058

FENCING		BANDING		SPRAYING		
FEET OF WIRE		BURLAP BANDS APPLIED	O. M. LARVAE & PUPAE CRUSHED	ACRES OF WOODLAND	RESIDENTIAL PROPERTIES	TREES IN OPEN
ERECTED	REMOVED					
586,685	664,493	2,110,813	18,799,226	15,631	5,766	114,252

FIG. 1.—Gypsy moth control work, July 1, 1936, to June 30, 1937.

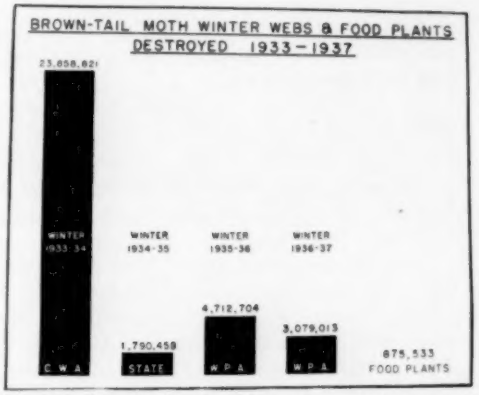

FIG. 2.—Graph showing destruction of brown-tail moth winter webs and food plants, 1933–37.

Fig. 1 shows the combined work conducted by the Bureau of Entomology and Plant Quarantine and the cooperating states concerned, including that done as a result of WPA allotments and details from CCC camps.

BROWN-TAIL MOTH PROJECT.—Under the brown-tail moth project, work was conducted in all of the New England states, with men paid from WPA funds, 95 per cent of whom were from relief rolls. All towns within the infested area were scouted, and all hibernating webs found were cut and destroyed. Some towns outside of the known infested area were examined to determine possible spread. In addition to the destruction of infestations, many worthless apple and wild cherry trees—favored food plants—were removed at sites of persistent infestations to decrease the chances of having this insect maintain its foothold. As a result of intensive work the infestation was reduced greatly in nearly all sections of the infested area.

Fig. 2 shows graphically the brown-tail moth webs destroyed and useless food plants eliminated from 1933 to 1937 under emergency projects.—1-19-38.

ADMINISTRATIVE instructions for the fumigation of certain produce when shipped *via* refrigerator car from the area generally infested with the Japanese beetle, as designated in regulation 5 of federal quarantine 48, were recently issued by the U. S. Bureau of Entomology and Plant Quarantine as circulars of the B.E.P.Q. series, nos. 473, 475 and 480, relating respectively to potatoes, opinions and tomatoes.

The Present Status of the Japanese Beetle Situation in St. Louis

J. Carl Dawson, *Missouri State Department of Agriculture*

The fourth year of Japanese beetle suppression and control work in St. Louis has been completed.

In 1934, when the work was begun, 2600 beetle traps captured 1351 beetles. In 1935, 10,000 traps captured 1232 beetles. In 1936, 14,000 traps captured 88 beetles. In 1937, 14,750 traps captured only one beetle.

During the four years that this work has been in progress all areas found to be infested were treated as promptly as possible with arsenate of lead at the rate of 1000 pounds per acre. During the first three years of this work 288.8 tons of lead arsenate were applied to 578.6 exposed soil acres, in a total city area of about 1806 acres.

Trapping in 1937.—The work in 1937 was carried on in much the same manner as in preceding years. Japanese beetle traps numbering 14,750 were placed and baited prior to the time the adult beetle was due to emerge. Heavy concentrations of traps were located in areas which had previously been found infested. Traps were set throughout the entire city of St. Louis and in adjacent county suburban areas.

On July 7, 1937, one female Japanese beetle was captured in a commercial area below and adjacent to the west approach of the St. Louis Municipal Bridge. This location is approximately three miles from the area where the beetle was originally found and where intensive suppression work has been carried on.

It is not unreasonable to believe that this beetle might have reached St. Louis by way of a freight car and, therefore, have no connection with the original infestation upon which so much suppression and control work has been done. The trap from which it was taken was located in an area contiguous to a freight yard where refrigerator cars are frequently sidetracked after returning empty from all parts of the United States, including the area of heavy Japanese beetle infestation along the East Coast. It is an industrial section of the city not well adapted to beetle infestation since it contains few of the favored host plants.

The area where this beetle was found was immediately treated for approximately 500 feet in all directions with arsenate of lead at the rate of 1000 pounds per acre. A total of 2750 pounds of poison was used for this work. A nearby flower and vegetable garden, separated from this trap only by a small building, was treated with double-strength carbon disulphide emulsion.

Checking on Traps.—As a check on the efficiency of the traps, hand scouting was begun on July 19, 1937, and continued until the adult beetle season was over. All sections in which beetles had been found in preceding years, and where it was thought they were likely to appear in 1937, were very carefully scouted.

Approximately 100 man-days of hand scouting, combined with the operation of 14,750 beetle traps, revealed only the single beetle captured on July 7, and failed to show any infestation remaining in the areas previously known to be infested and which had been previously treated with arsenate of lead.

Plans for the Future.—This reduction in the population of Japanese beetles in St. Louis from 1351 captured in traps in 1934 to a single beetle, of questionable connection with the original infestation, captured in 1937 is a strong indication that the infestation has been eradicated. There is a possibility, however, that a very slight infestation may remain. Such an infestation might possibly exist several blocks from areas which were previously known to be infested and where traps have not been concentrated, but were set at the rate of one per block. Because of the possibility of such a slight infestation, which would be capable of undoing all that has been accomplished, no reduction in the amount of trapping is contemplated for the 1938 season.

Plans are now being formulated for continued cooperation of the Missouri State Department of Agriculture, the Federal Bureau of Entomology and Plant Quarantine, the Works Progress Administration, and the City of St. Louis Parks Department to carry on the trapping work in 1938 on the same basis as in 1937.—1-8-38.

Present Status of Barberry Eradication and White Pine Blister Rust Control

S. B. Fracker, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

Grain Rust Control.—It is probable that, in the diversity of its far-reaching effects and in the magnitude of the values involved, no pest control project ever undertaken compares with the attempt to control black stem rust of grains.

The crops attacked—wheat, oats, barley and rye—are the very foundation of the human food supply, and black stem rust can, and occasionally does, destroy grain production valued at over $100,000,000 in a single season. Severe damage was reported repeatedly before barberry eradication was undertaken, and has occurred occasionally since that time under special circumstances.

Life History of the Fungus.—Careful examinations of the life history of the fungus show two means by which it can live through from one growing season to the next; these are (1) the survival through the winter of the red, or summer, stage whose spores spread the rust from field to field while the crop is maturing and (2) the germination, on barberry plants in the spring, of the aecial stage, arising from infection with the black spores produced on the stubble and straw late in the summer and remaining there throughout the winter months.

The red or uredial stage survives the winter only in subtropical climates; this source of rust is therefore a factor only when conditions make possible the northward spread of the rust spores in the spring and early in the summer. The immediate local source of the continuous year-to-year damage from rust so common from 1880 to 1916 can be charged directly to the infection on barberry plants.

Early Control Measures.—Twenty years of experience since barberry eradication was begun about 1918 have shown it to be a much larger undertaking than was at first anticipated. The destruction of the barberry plants around city dwellings and in most of the rural farmsteads was substantially carried out in most of the 13 states during the first three or four years of the undertaking but proved to be only the first and simplest phase of the problem. The barberry had escaped widely from cultivation, and the extent of its distribution in woodlands and pastures has proved to be enormously greater than had been believed.

For the decade beginning about 1922, the agencies cooperating in barberry eradication struggled with the barberry "escape" problem and destroyed millions of bushes. With federal appropriations of such size that the state allocations ranged from $10,000 to $20,000 per year per state, the leaders attempted to take each center of escaped barberries in turn and to kill the bushes as rapidly as they could be found.

During the latter part of this decade when appropriations were gradually reduced in connection with economy measures, the organization was not able even to keep up with the natural spread. It is not improbable that more barberry plants actually existed in the northern grain-growing states in 1932 than in 1925.

Recent Control Measures.—In 1933, however, the barberry eradication organization, which had previously always suffered from a lack of sufficient men to do the work, found itself for the first time with as large supplies of laborers as could be absorbed, trained and supervised.

Advantage has been taken of every opportunity to obtain relief labor for assignment to this project. Regular appropriations averaging about $200,000 per year have been supplemented during the past five years with emergency funds of some $5,000,000 for labor and for the purchase of salt for killing the barberry plants.

These appropriations have been translated into vigorous action. Where previously it had been necessary for one or two men to start from known centers and work out until barberries became few and far between, it has been possible since 1934 to cover entire counties and large sections of entire states on strip-line surveys in which every square rod was either visited or seen from a distance close enough so that the worker could be certain that no barberry plants were there.

In the case of six plains states—North Dakota, South Dakota, Nebraska, Mon-

tana, Wyoming and (eastern) Colorado—all those parts of each state that seemed to offer much likelihood that barberry bushes would be growing on them have been covered once, and where necessary twice, and it is believed that by next year the strip-scouting phase of the program within this area can be considered complete. Labor may be needed from time to time in the future to destroy barberry plants developing from seed now dormant in the soil, and it will be necessary to maintain from one to several men in each state for a number of years to make continuous surveys of old locations to find where such dormant seed is germinating. In the great plains area, however, it is believed that the barberry-eradication program is definitely on the last lap; here 15,326 barberry plants have been destroyed on 804 properties since August, 1933, as a result of strip-line surveys covering approximately 28,655 square miles. Intensive effort during the past year in this group of great plains states has resulted in the location and destruction of 944 plants of *Berberis vulgaris* and 1188 seedlings.

In the upper Mississippi Valley states—Iowa, Minnesota, Wisconsin and Illinois—the problem has been much more difficult and the work is not yet so far along. Since emergency labor first became available, 521,466 barberries have been destroyed on 10,487 properties, and 67,341 square miles have been covered on strip-line surveys in these four states. Regeneration will continue to be a problem, but a personal survey in this region this past fall convinces me that the situation is no longer discouraging and that the completion of the program, while not yet in sight, is at least attainable. During the last four years it has at least been possible to prevent most of the new seedling bushes from reaching fruiting size before they were located and killed.

Farther east, in parts of Indiana, Michigan and Ohio, a somewhat similar stage has been reached. It has been particularly encouraging to note the apparently almost complete and permanent destruction of barberries in some of the barberry "escape" areas which 3 to 10 years ago looked almost hopelessly persistent. In parts of these three states a serious, long-time problem still remains.

In 1935 four additional states—Missouri, Pennsylvania, Virginia and West Virginia—took advantage of the opportunity offered by emergency allotments to undertake a similar eradication program, and the work was also extended to areas of the native *Berberis fendleri* in southwestern Colorado. Stem rust had become so severe in many of the important grain areas of these states that it was becoming practically impossible to mature a crop without material damage. Observations of rust in connection with the 1936 and 1937 crops in the Virginias and Pennsylvania have shown that rust damage was much less severe in valleys where bushes were destroyed in 1935 than in similar localities where bushes still remained. The work in these states is strongly supported by local agricultural authorities, and particularly by the grain growers who have benefited by, or have seen the results of, the destruction of several million barberries in the last several years.

The stem rust epidemics of 1935 and 1937 in the Middle West, following an extended period of years when losses from this source were practically negligible, have resulted in the revival of considerable interest in the rust problem on the part of both grain growers and processors. In 1935 and again in 1937 crop conditions and weather favored the northward movement of rust from overwintering areas in Texas and Mexico and the rapid build-up of inoculum in the winter-wheat States of Kansas, Nebraska and Missouri. From there the epidemics spread into the spring-wheat areas, where the lateness of the crops set the stage for heavy losses.

The fact that weather and crop conditions making possible this heavy northward movement of rust have existed only rarely during the past 20 to 25 years offers one source of encouragement. In the meantime the Bureau of Plant Industry is cooperating with state agricultural experiment stations of the Middle West to develop more rust-resistant varieties of grain for distribution in the winter-wheat belt. Success in this direction will serve further to minimize the importance of the southern inoculum, and completion of the barberry eradication program will eliminate the local sources of spread. Grain breeding and barberry eradication form

the foundation on which are built our hopes for eventual stem rust control in the United States.

BLISTER RUST CONTROL.—The most important new development in the white pine blister rust control project during the year 1937 was the discovery of the spread of the rust on *Ribes* over the northern quarter of California. A few cases of infection along the northern border were found in 1936, but this year infections on *Ribes* were found to be generally distributed in Siskiyou County, and scattered infections were found in Shasta, Trinity and Tehama counties, some of them 125 miles south of the Oregon border, in both the Coast Range Mountains and the Sierra Nevada. No disease was found on sugar pine this year.

Previous findings on sugar pine in southern Oregon demonstrated that field and weather conditions permit the disease to damage sugar pine severely, killing trees up to 40 feet in height within approximately 10 years. This indicates the possibility of a more rapid attack on sugar pine by the fungus than has been the case with either northern white pine (*Pinus strobus*) or western white pine (*Pinus monticola*).

DISCOVERIES OF INFESTATION ELSEWHERE.—Scouting in a southeasterly direction from the known limits of the disease in Idaho resulted in the discovery of the rust on *Ribes* at 16 points distributed on four national forests in Montana. Four of these points involve for the first time locations east of the Continental Divide in the northwestern region, and one of them is within 19 miles of the northwestern corner of Yellowstone National Park.

In the north central region the rust was found in Palo Alto County, in northwestern Iowa, and in McHenry, Winnebago, Boone, Lake and Kane counties in northern Illinois. Limited scouting in Indiana gave negative results, and in Ohio the rust was found on *Ribes* in Fairfield and in Lorain counties for the first time.

In the southern Appalachian region the rust was discovered for the first time in the state of Delaware, in Newcastle County, on cultivated black currants. In Maryland the disease was found east of its previously known range on cultivated red currants in Carroll, Harford and Baltimore counties. The southern limit of spread in the Appalachians was extended to include Allegheny County in Virginia and Greenbriar County in West Virginia.

These facts as to blister-rust distribution are valuable as a basis for planning field operations, but they do not materially affect the success of control. *Ribes* eradication protects local pine stands regardless of the presence of blister rust in the vicinity. This eradication work has gone forward rapidly during the last four years as a result of the allotment of emergency funds to this project from various appropriations for the relief of unemployment. Control work requires large amounts of man power, and the adaptability of the project for relief of unemployment through its ability to utilize labor made possible large-scale *Ribes* eradication in white pine areas.

PRESENT STATUS OF CONTROL.—In the country as a whole there are estimated to be approximately 23,500,000 acres of white pine of which about 15,500,000 acres are worth protecting from blister rust. When we add the acreage in the protective zones around these stands, the total control area is increased to more than 26,000,000 acres. These figures are expected to be considerably higher when pine surveys now in progress are completed. At the end of the calendar year 1936, 18,572,799 acres of the control area had received initial protection by the eradication of 704,705,524 *Ribes*. In addition, 3,184,999 acres had received a second working and 15,722 acres a third working. During 1937 a total of about 2,247,694 acres were protected by the eradication of 73,174,739 *Ribes*. These 1937 figures include both initial and rework.

Of the total control acreage worked up to the present time, over 50 per cent has been covered during the last four years as a result of emergency programs. The remainder has been worked under the regular cooperative program carried on since 1918 by the Department and affected state and local agencies.

The situation with respect to the control of the disease differs considerably in the several white pine regions of the country. In the northeastern states about 80 per cent of the control acreage has been given initial protection and in addition considerable rework has been accom-

plished. In the north central states approximately 40 per cent of the control acreage has been given initial protection. The work in this region, and also in the southern Appalachian region where approximately 65 per cent of the area has been given initial protection, was not begun on a large scale until the advent of the emergency programs.

In the Pacific Northwest 63 per cent of the control acreage has received initial protection, and the *Ribes* have been initially eradicated from about 21 per cent of the valuable sugar pine stands of California and Oregon.

IMPROVEMENT OF CONTROL PRACTICES.—Attention has been given to the improvement of control practices along with the application of control measures. One of the principal developments has been a further improvement of the bulldozer which is used in the western white pine forests to clear certain stream-bottom areas of brush and *Ribes* that are difficult and costly to work by hand methods.

Although the bulldozer work is expensive, it is estimated that the hay crop and grazing fees from the land covered will pay for the work within a few years, besides protecting very valuable reproduction and pole stands of white pine from losses resulting from blister rust infection.

Another development in eradication methods consists of the chemical destruction of *Ribes* growing in inaccessible places, such as under stones or logs, where the bushes are difficult to remove by grubbing. This method consists of decapitating the bushes by cutting through the crown below ground level with a form of grub hoe known as a "Pulaski" and then applying from 2 to 3 ounces of borax or a dry mixture of *Atlacide* and borax (1 to 5) or applying 2 to 3 fluid ounces of Diesel oil. Other chemicals and combinations of chemicals are being tested from time to time with a view of developing new materials for destroying *Ribes* the application of which will involve less expense than the methods now in use.

One procedure that is being used on an increasing scale in the Northeast is the salvage of many ornamental pines and trees situated along roadsides, in parks, or on estates which were infected several years ago before the *Ribes* were eradicated. Such work has been done on a number of publicly owned stands of high value, particularly in Acadia National Park and in several state plantations in New York. Treatment consists of cutting out the diseased portions, and where the trees are fatally infected by stem cankers the entire tree is removed. At the end of October, 1937, a total of 6,215,895 pines had been examined, 152,358 fatally infected trees had been cut down and 683,081 cankers had been removed from 205,048 treated trees. This work, most of which has been carried out since 1934, has resulted in the saving of large numbers of ornamental pines that otherwise would have been destroyed by blister rust.

The blister rust control work has largely been financed during recent years through substantial allotments from the several emergency relief appropriation acts and a large per cent of the labor for *Ribes* eradication has thus been taken from relief rolls. Net allotments to the Bureau of Entomology and Plant Quarantine for field operations in blister rust control for the fiscal years 1934 and 1935 totaled $2,016,520, in the fiscal year 1936 amounted to $4,407,804 and in the fiscal year 1937 were $2,904,625. Net allotments made thus far for the current fiscal year total $1,576,255, a sum which is expected to carry the work through June 30, 1938.—1-8-38.

The Ratio of Lead to Arsenic in Spray Residues from Lead Arsenate*

G. W. PEARCE and A. W. AVENS, *New York State Agricultural Experiment Station, Geneva*

Information is available† concerning the chemical reactions which occur when dilead arsenate ($PbHAsO_4$) is mixed with various other spray materials in the spray tank. However, little is known of the reactions involving this material at leaf or fruit surfaces. Since commercial lead

* Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 206, May 17, 1937.

† See Mogendorff (1925) for extensive literature review.

arsenate is practically pure dilead arsenate and consequently consists of lead and arsenic combined in a specific ratio, one may obtain at least indications as to what processes may be occurring on fruit and foliage surfaces by a consideration of the ratio of lead to arsenic in the residues from lead arsenate sprays. The weight ratio of lead to arsenious oxide in dilead arsenate is 2.09. Thus, any factors operating to remove arsenic and lead from lead arsenate residues in a different ratio will be indicated by the ratio of lead to arsenic in the remaining residue. This ratio of course may be calculated from the results of residue analyses for arsenic and lead.

In the course of seven years of residue investigations at this station approximately 4,000 samples of farm produce have been analyzed for spray residue. A large number of these samples were taken from apple orchards in which various spray programs were under test for the control of codling moth. Since lead arsenate sprays have been the standard of comparison in these experiments, an opportunity to study the lead to arsenic ratio, calculated from the residue analyses presents itself. This paper shows some observations with respect to the ratios occurring in residues at harvest and after removal by washing procedures as well as the residue load from various numbers of so-called "cover" sprays. A theoretical discussion of some possible factors affecting the ratios is included.

Several methods of residue analysis have been tried in the writers' laboratory. However, the data to be presented have been obtained only from analyses for which the Samuel & Shockey (1934) method has been employed. Moreover, the data are taken from field tests of 1935 and 1936 only.

DATA.—Table 1 presents data to show the average residue load from various numbers of lead arsenate sprays applied under experimental conditions in New York state. In general fruit growers of this state apply lighter sprays than these results would indicate. However, application of more than one cover spray whether under commercial or experimental conditions usually results in a residue load in excess of the present tolerances (.010 grs. As_2O_3/lb., .018 grs. Pb/lb.).

It is also of interest to note that an appreciable residue remains from the calyx spray. It has been frequently assumed by field workers and others that no residues are found on fruit from the calyx spray. This is contrary to fact. Although the average amount of calyx spray residues is small as shown in table 1, in cases where the calyx spray is followed by oil-nicotine sprays, as much as .003 grs. As_2O_3 and .009 grs. Pb per lb. have been found on the fruit at harvest.

The ratios of lead to arsenious oxide (Pb/As_2O_3) given in table 1 show that the arsenic is lost at a rate greater than that of lead since all of the ratios are higher than the ratio in dilead arsenate. While this tendency to lose arsenic faster than lead is influenced by a large number of factors in the field, this phenomenon has been the general experience with lead arsenate residues under New York state spraying conditions.

In considering what processes are oc-

Table 1.—Residue loads and ratios of lead to arsenious oxide on apples at harvest from calyx and various numbers of cover sprays.

Number of Spray Plots	Treatment*	Average Time from Last Application to Harvest†	Average Residue Load at Harvest Grains per Pound Pb	As_2O_3	Ratio Pb/As_2O_3
8	Calyx	120 days	.003	.001	3.0
9	Calyx+1 cover L. A.	100 days	.016	.006	2.7
7	Calyx+2 cover L. A.	80 days	.035	.014	2.5
7	Calyx+3 cover L. A.	65 days	.060	.026	2.3
3	Calyx+4 cover L. A.	50 days	.084	.038	2.2
7	Calyx+5 cover L. A.	35 days	.167	.075	2.2

* Calyx sprays = Lead arsenate, 3 lbs./100 gal.+lime sulfur (1–40) or a wettable sulfur.
Cover sprays = Lead arsenate (L.A.), 3 lbs. /100 gal. + fungicide of Bordeaux or a wettable sulfur.
† Approximate application dates: Calyx, May 20–25; 1st cover, June 15; 2nd cover, July 1, 3rd cover, July 15; 4th cover, August 1; 5th cover, August 15.
Average harvest date, September 20 (Varieties = Wealthy, Greening, McIntosh, Baldwin, Stark)

curring at fruit or leaf surfaces which would tend to cause arsenic to be removed faster than lead, one must keep in mind the time factor. The calyx spray, for example, is exposed about three times as long as the fifth cover spray and, hence, is subject to a longer action of rains and dews. One might also expect that the later sprays would afford some protection from weathering for the earlier sprays and thus tend to bring the ratio toward that for lead arsenate. In general, then, single sprays applied early in the season tend to leave residues at harvest having a high ratio, whereas the ratio in residues from several sprays applied throughout the growing season tends to approach that of dilead arsenate.

DISCUSSION.—There are several possible reactions which can take place in spray residues on fruit or foliage surfaces which would promote loss of arsenic faster than lead. These reactions usually involve the fungicide or other spray material applied with the lead arsenate. In the case of the data given in table 1 the fungicide is a variable. A close examination of the data from which table 1 was compiled showed no significant differences in the ratios obtained from residues resulting from lead arsenate plus the several fungicides indicated. This observation is in accord with the following discussion of the reactions between lead arsenate and other spray materials.

It has long been known that lead arsenate and lime sulfur react to some extent to form lead sulfide and a calcium arsenate. Recent work at this station has indicated that by the time a lead arsenate and lime sulfur spray has been applied and allowed to dry on the foliage, 30 per cent or more of the lead arsenate is converted even in the presence of lime. The calcium arsenate formed by this reaction is much more soluble than the lead sulfide and accordingly would be dissolved out of residues of such a spray mixture in larger amounts than the lead sulfide. The result would, of course, appear in the form of a high ratio of lead to arsenic in the remaining residues.

In those instances where a wettable sulfur has been employed as a fungicide, a similar reaction probably occurs. Recent evidence (Martin 1936) indicates that elemental sulfur is slowly converted to hydrogen sulphide when applied to foliage. In the presence of lead arsenate, arsenic acid and lead sulfide would be formed in all probability. Hence, arsenic would be lost faster than lead from residues of this combination.

The reactions involved with sprays of lead arsenate and Bordeaux also promote a greater loss of arsenic than of lead. Streeter & Pearce (1931) have shown that lime and calcium carbonate react with lead arsenate to form varying amounts of soluble arsenic. Since the Bordeaux used in the sprays as indicated in table 1 contained an excess of lime, it is obvious that again we have a spray mixture whose residues would probably lose arsenic faster than lead.

A fourth reaction which should be considered of some influence is that between lead arsenate and water. McDonnell & Graham (1917) have demonstrated that dilead arsenate is slowly hydrolyzed to a basic lead arsenate by the action of water. The basic arsenate has a weight ratio of 3.49. Consequently, the presence of moisture from rains and dews would be favorable to hydrolysis and a resulting high ratio in the residues.

Table 2.—Effect of oil sprays on ratio of lead to arsenious oxide in lead arsenate residues on apples at harvest.

Number of Spray Plots	Treatment L. A. Calyx	L. A. Covers*	Oil Spray	Average Ratio Pb/As_2O_3
5	1	0	0	3.6
2	1	1	0	2.8
2	1	2	0	2.7
2	1	3	0	2.4
3	1	4	0	2.3
2	1	5	0	2.3
6	1	1	2	2.4
4	1	4	2	2.2
1	1	4	3	2.1
5	1	5	2	2.2

* Calyx = Lead arsenate, 3 lbs./100 gal. + 1–40 lime sulphur.
Cover = Lead arsenate (L. A.), 3 lbs./100 gal. + fungicide of Bordeaux or a wettable sulphur.
Oil sprays = Summer oil applied with lead arsenate or nicotine.
(See table 1 for approximate application dates.)
Varieties = Greening, McIntosh, Wealthy.

In table 2 data are presented to show the effect of oil sprays applied with or following lead arsenate and fungicide sprays on the ratio of lead to arsenic in the residues at harvest. It is observed from these data that the oil sprays tend to pre-

vent the loss of arsenic faster than lead from the residues. This is in accord with the general experience that oil sprays lock both arsenic and lead to such an extent that it is usually necessary to modify the procedure for residue removal from fruit having such sprays.

In the course of studies of fruit-washing procedures it has been observed that arsenic is removed more readily than lead from fruit sprayed with lead arsenate under New York state conditions. Table 3 presents data to show rather clearly this observation. The average ratio of lead to arsenic in the initial residue loads is 2.2; while the averages after washing with and without a wetting agent are 2.4 and 2.5, respectively. The apparent improvement in efficiency of lead removal with a wetting agent indicated by the latter averages is not considered significant.

Table 3.—The ratios of lead to arsenious oxide in lead arsenate residues on apples at harvest before and after washing.

SAMPLE*	RATIOS Pb/As_2O_3 IN RESIDUE LOADS AT HARVEST	RATIOS Pb/As_2O_3 IN RESIDUE LOADS AFTER WASHING	
		1 AND 1½% HCl	1 AND 1½% HCl+A WETTING AGENT
1	2.2	2.3	—
2	2.2	2.2	—
3	2.3	2.4	—
4	2.0	2.6	2.7
5	2.0	2.3	2.6
6	2.1	2.4	2.5
7	2.1	2.5	—
8	2.2	2.6	2.4
9	2.1	2.7	2.3
10	2.2	2.2	2.0
11	2.2	2.7	2.5
12	2.4	2.5	—
13	2.5	2.5	—
14	2.3	3.0	—
15	2.4	2.5	2.5
16	2.5	2.7	—
17	2.2	2.7	2.5
Minimum	*2.0*	*2.2*	*2.0*
Maximum	*2.5*	*3.0*	*2.7*
Mean	*2.2*	*2.5*	*2.4*

* Each sample taken from a different spray plot. Spray program consisted of a calyx+3 to 5 cover sprays of lead arsenate with and without oil. Fungicides of lime-sulphur, wettable sulphur and Bordeaux were used.

The fact that dilute hydrochloric acid removes arsenic more efficiently than lead from lead arsenate residues as evident from the data in table 3 lends support to the theory that through a variety of chemical processes, such as those suggested in previous paragraphs, lead arsenate, alone and in spray combinations is slowly decomposed into other lead and arsenic compounds or complexes which resist removal by weathering or washing to a different degree. The present data indicate that, in general, the arsenic complexes are more easily removed than the lead.

SUMMARY.—The ratios of lead to arsenious oxide (Pb/As_2O_3) in residues at harvest from lead arsenate sprays applied under New York state conditions tend to be higher than the ratio in dilead arsenate. This tendency is more pronounced in residues which have been exposed to long periods of weathering. It is less pronounced when oil has been applied with or following the lead arsenate sprays.

The ratio of lead to arsenious oxide in residues on fruit washed with hydrochloric acid with and without wetting agents is definitely higher than that in residues on the unwashed fruit.—1-20-38.

LITERATURE CITED

Martin, H. 1936. The scientific principles of plant protection. pp. 105–9. Edward Arnold and Co. London. 2nd. Ed.

McDonnell, C. C., and J. J. T. Graham. 1917. The decomposition of dilead arsenate by water. Jour. Am. Chem. Soc. **39**: 1912.

Mogendorff, N. 1925. Some chemical factors involved in arsenical injury of fruit trees. N. J. Ag. Exp. Sta. Bul. **419**.

Samuel, B. L., and H. H. Shockey. 1934. A rapid and accurate photometric method for determination of lead in small quantities. Jour. Assoc. Offic. Ag. Chem. **17**: 141.

Streeter, L. R. and G. W. Pearce. 1931. Reactions involved in the use of hydrates in lead arsenate sprays. Jour. Ind. Eng. Chem. **23**: 1140.

The Relation of Concentration of Active Ingredient to Insecticidal Efficiency of Dusts*

LESLIE M. SMITH, *University of California, San José*

The following study attempts to compare the relative efficiency of different concentrations of insecticidal powders. Is 10 pounds per acre of an 80 per cent poison mixture exactly as effective as 20 pounds of a 40 per cent mixture of the same poison? If the diluent is non-toxic the obvious answer to this question is affirmative. The following study indicates that in certain cases, at least, toxicity or field efficiency is not proportional to the concentration of active principle, nor do equal poison applications of various dilutions result in equal kills of insects.

METHOD.—In this study, the single poison, barium fluosilicate, was used with talc as a diluent. The test insect was the snowy tree cricket, *Oecanthus niveus* (De G.) race B. The dust was applied to raspberry leaves by sedimentation in a chamber 2 by $1\frac{1}{2}$ by $1\frac{1}{4}$ feet. Dusts were defloculated by blowing in a vertical glass cylinder 2 inches in diameter and 8 inches high. An air blast from a motor driven pump was introduced at the bottom of the cylinder. From this cylinder the dusts were conducted in an air stream to the sedimentation chamber. Repeated tests showed that four glass plates, placed near the four corners of the box, received a deposit of dust at a rate which when averaged represented the rate per unit area deposited along the sides of the chamber.

The various mixtures were prepared following a careful weighing of the components, which were mixed and stirred for several minutes by hand and then run in a motor driven ball mill for 20 minutes. Three samples of the 50 per cent mixture were separately loaded and run into the sedimentation chamber. These were then collected. By chemical analysis the amount of barium fluosilicate in each was found to be 50.51 per cent, 50.69 per cent and 50.83 per cent.

This test shows that a thorough mixing was achieved and that no elutriation occurred as the dust was blown into the sedimentation chamber. Moreover, these three samples were taken from different positions on the floor of the chamber, which shows that the deposit maintained the proper proportions throughout. As a further test, a considerable amount of a 30 per cent mixture was placed in the dust reservoir and the air stream was run through it until about half of the dust had been carried away. The remainder in the reservoir was then analyzed and found to contain 29.11 per cent barium fluosilicate, which again shows that no elutriation occurred in the cylinder.

Four raspberry leaves of approximately the same size were placed along the sides of the sedimentation chamber. The dust which fell on 52 square inches of glass plates was weighed and assumed to be at the same rate as the dust deposited on the leaf surface. After dusting, the leaves were placed, petioles in water, in screen cages, 12 inches square and 16 inches high. Ten crickets, either males or females, were placed in each cage.

The natural mortality was determined by caging 10 males or females together with undusted raspberry leaves. The natural food of this insect in raspberry patches consists largely of flower parts, and, since these could not be supplied, the crickets were fed ripe raspberries from time to time. In no case were the berries dusted. Water was available to the crickets at all times.

Every two days following the establishment of a cage, the number of crickets still alive was counted and the number dead was obtained by subtraction. The number of dead crickets could not be counted since one or two dead ones are usually completely eaten by the remaining eight or nine during a single night.

RESULTS.—A higher natural mortality occurred among males than among females. This may be related to the fact that the cricket is a univoltine insect and the males reach maturity before the females. Nine check cages of males and eight cages of females were established. The natural mortality is given in table 1. The average values for natural mortality (table 1) were graphically smoothed to a straight line and coordinates of points on this line were used to correct mortality

* Valuable laboratory assistance on this problem was rendered by the WPA Project No. 4733.

data from poison treatments. The percentage of crickets dead in each cage every two days for 16 to 20 days after dusting was corrected for natural mortality by the formula:

$$\frac{D - N}{10 - N} \times 100$$

wherein D = the number of crickets dead on a particular day after dusting, and N = number of crickets of the same sex dead in the checks on the same day. Ten is the total number of crickets in each cage.

The corrected mortality, or percentage of crickets killed by poison was graphed for each cage, as shown in fig. 1. A smooth curve was fitted by eye, and in this manner daily variations from the expected were somewhat corrected. From smooth curves prepared for each of the cages in this manner, the percentage mortality on the fourteenth day was read. It was found that death from the poison usually first appeared on the second or third day, increased rapidly in rate until the ninth to the twelfth day, whereupon

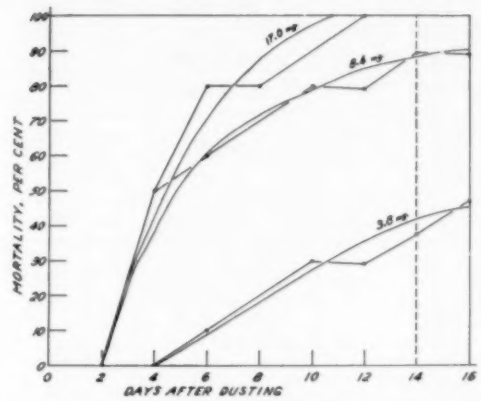

FIG. 1.—Illustration of the method of smoothing mortality on time. Herein are represented actual mortality counts, after correction for natural mortality, of three applications of 80 per cent barium fluosilicate. The rate of application per 52 square inches is shown on each curve. The dotted, 14-day line is used for reading the mortality.

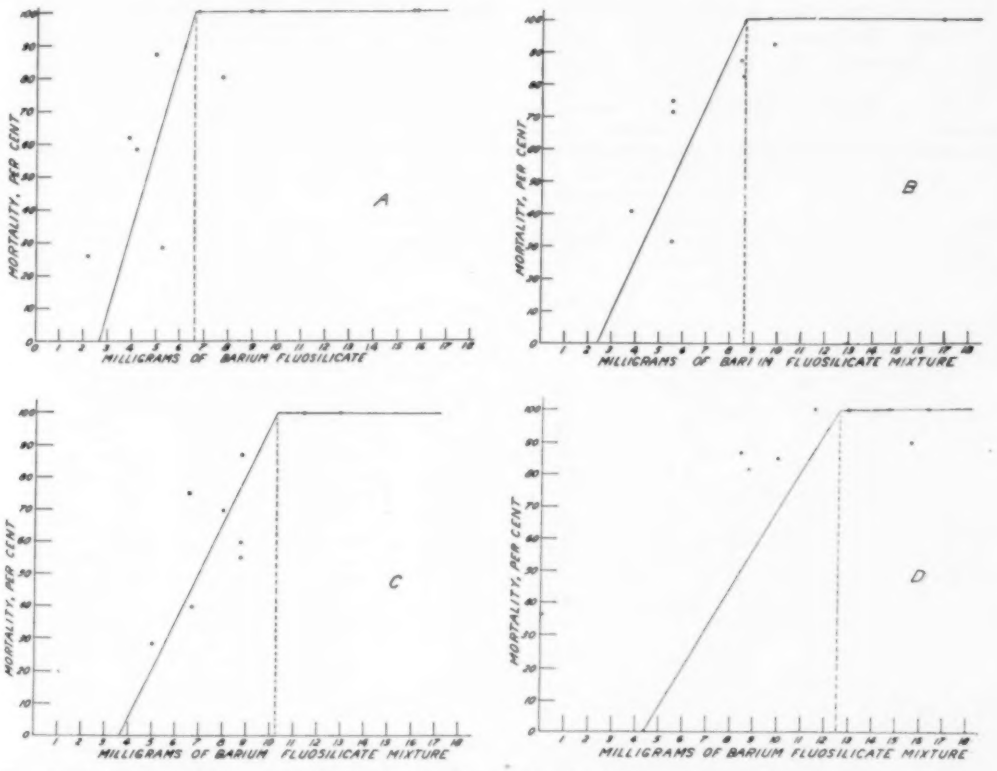

FIG. 2.—Mortality and concentration of barium fluosilicate. A = 100 per cent; B = 80 per cent; C = 50 per cent; and D = 30 per cent. Each point represents one cage containing 10 crickets and has been read from smoothed curves as shown in fig. 1, at the expiration of 14 days.

Table 1.—Natural mortality in cages; 10 crickets per cage.

Cage Number	Males							Females						
	Days After Caging							Days After Caging						
	2	4	6	8	10	12	14	2	4	6	8	10	12	14
	Number Dead							Number Dead						
1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
2	2	2	2	2	2	2	4	0	0	0	0	0	1	1
3	0	0	0	0	0	0	1	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	1	3	3	3	3	0	0	0	0	0	0	1
7	0	0	0	1	1	1	1	0	0	0	0	0	0	0
8	0	0	1	1	2	2	2	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0							
Average	*0.22*	*0.22*	*0.44*	*0.77*	*1.0*	*1.11*	*1.44*	*0*	*0*	*0*	*0*	*0*	*0.13*	*0.25*

it ceased. Hence when mortality was plotted against time, as in fig. 1, the curves generally flattened horizontally somewhere between the ninth and twelfth days. Therefore, the fourteenth day was selected for reading the mortality. In this manner, the data in table 2 were obtained.

When these data are prepared graphi-

Table 2.—Mortality obtained from various concentrations of barium fluosilicate with talc as a diluent.

100 Per Cent Concentration		80 Per Cent Concentration		50 Per Cent Concentration		30 Per Cent Concentration	
Mg. Per 52 Sq. In.	Per Cent Kill	Mg. Per 52 Sq. In.	Per Cent Kill	Mg. Per 52 Sq. In.	Per Cent Kill	Mg. Per 52 Sq. In.	Per Cent Kill
2.2	26	3.8	41	5.0	28	4.4	0
3.9	62	5.5	32	6.6	75	8.4	87
4.2	58	5.5	72	6.7	40	8.8	82
5.0	87	5.5	75	8.0	70	10.0	85
5.3	28	8.4	88	8.8	55	11.5	100
6.8	100	8.5	83	8.8	60	12.9	100
7.8	80	9.8	93	8.8	87	15.6	90
8.9	100	17.0	100	11.4	100	16.3	100
9.3	100			13.0	100	20.9	100
15.7	100			18.8	100	23.2	100
15.8	100			19.9	100	28.5	100
27.8	100			20.7	100	30.3	100
28.4	100			21.0	100	39.3	100

cally the curves shown in fig. 2, A, B, C and D are obtained. In these graphs the best fitting straight line has been used, although a sigmoid curve may actually represent the relation between rate of application and mortality. The least application which yielded a complete kill was selected for comparison of the four

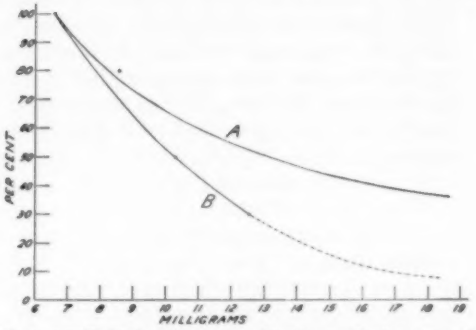

FIG. 3.—Relation between the theoretical rate and experimentally determined rate of application of various concentrations of barium fluosilicate. The ordinate figures are concentration of barium fluosilicate in per cent; the abscissa values are milligrams of mixed dust, per 52 square inches, necessary to yield a 100 per cent control, as derived from fig. 2. Curve A is computed on the theory that 6.6 milligrams of barium fluosilicate must be deposited regardless of concentration. Curve B is based on experimental data from fig. 2. The difference between the abscissas on curves A and B for any given percentage represents the reduction, in milligrams, per 52 square inches, from the theoretical to actual rate of application.

Table 3.—Values obtained from the graphs in Fig. 2.

CONCENTRATION OF BARIUM FLUOSILICATE, IN PER CENT	AMOUNT NECESSARY TO GIVE A 100 PER CENT KILL, IN MILLIGRAMS PER 52 SQ. IN.
100	6.6
80	8.6
50	10.25
30	12.5

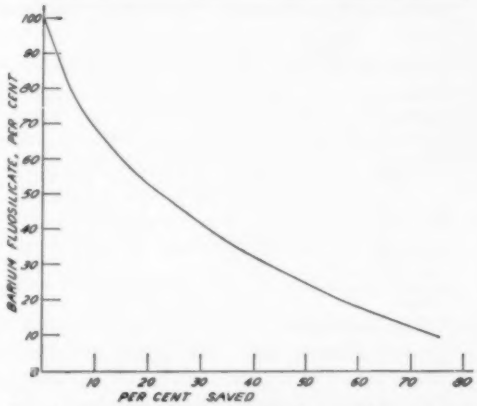

FIG. 4.—Relation of concentration to the per cent of barium fluosilicate which is saved by using more dilute dusts.

Table 4.—Comparison of actual amount of barium fluosilicate necessary to produce a 100 per cent kill with the theoretical amount in which the rate of poison application is held constant.

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Barium Fluosilicate in Per Cent	Equal Poison Basis, Computed in Milligrams	Actual Poison, in Milligrams	Difference, Column 2—Column 3	Saving of Barium Fluosilicate Over Estimated Amount, in Per Cent 4/2×100
100	6.6	6.6	0.0	0.0
90	7.33	7.15	0.18	2.5
80	8.25	7.85	0.40	4.8
70	9.42	8.55	0.87	9.2
60	11.0	9.35	1.65	15.0
50	13.2	10.25	2.95	22.3
40	16.5	11.35	5.15	31.2
30	22.0	12.50	9.50	43.2
20	33.0	14.20	18.80	57.0
10	66.0	16.80	49.20	74.5

dilutions used. This was taken as the intersection of the straight line with the 100 per cent mortality line. In each graph, fig. 2, a dotted perpendicular line has been drawn to facilitate reading of this point on the milligram scale.

From the graphs, fig. 2, the values given in table 3 were obtained. These values are compared graphically, fig. 3, curve B, with theoretical values in which the amount of poison deposited per unit area is held constant, fig. 3, curve A. By extrapolation of curve B, further values have been obtained for comparison as shown in table 4. This table and the graph fig. 4, indicate that the dilute dusts are much more effective per unit of poison than are the concentrated dusts.

Table 5.—Cost of control.

Barium Fluosilicate Per Cent	Cost on Equal Poison Basis, Dollars	Cost on Actual Basis, Dollars
100	66.00	66.00
80	67.65	64.37
60	70.40	59.84
40	75.90	52.21
20	92.40	39.76

The reason for this phenomenon is unknown. It may be explained as a result of the manner in which the snowy tree cricket ingests the poison. It is well known that the poison is not ingested with the food, since the food in the field consists of unopened and freshly opened flower buds; and in these tests the food consisted entirely of fresh, ripe, undusted raspberries. Rarely, if ever, were the dusted raspberry leaves eaten. The poison was ingested by the crickets while cleaning their bodies and appendages with their mouthparts. When a diluted poison was used, more dust was present on the leaves, which in turn may have led to more frequent cleaning and hence ingestion of a greater bulk of dust. In this manner, the weight of dust consumed may have been increased more rapidly than the rate of dust per unit area of leaf surface.

Cost of Control.—Inasmuch as the dilute dusts are more effective per unit of poison than are the concentrated dusts, the cost of control with dilute dusts might be expected to be less. In table 5 the cost of control has been computed from the theoretical prices of barium fluosilicate 10 cents per pound and diluent 1 cent per pound. It is assumed that an area is involved which will require 660 pounds of 100 per cent barium fluosilicate. This area would then require 825 pounds of 80 per cent barium on an equal poison basis or 785 pounds of an 80 per cent dust according to experimental results, etc. The costs given in table 4 are for materials only. Other costs, however, such as mixing, labor, cost of packaging, freight, etc., must be taken into consideration and in actual practice are often large enough to more than compensate for the saving of the active ingredient.—2-7-38.

Species and Distribution of Grasshoppers Responsible for Recent Outbreaks

Robert L. Shotwell, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

During the period from 1917 to 1924 outbreaks of grasshoppers occurred in the Dakotas, Montana and Wyoming. They became especially widespread and destructive in North Dakota in 1919 and in Montana in 1923 (Cooley 1925). In these outbreaks *Melanoplus mexicanus* (Sauss.) was the most numerous and destructive although *M. bivittatus* (Say) was abundant in the heavy sod and irrigated areas and was second in importance. Other species less numerous but still important in these outbreaks were *Camnula pellucida* (Scudd.), *M. femur-rubrum* (De G.) and *M. packardii* (Scudd.).

In 1924 the outbreaks became localized in Montana, and the fall survey showed few eggs deposited anywhere. One report was received in June, 1925, of grasshoppers hatching along the Marias River bottom in southwestern Hill County, northern Montana. Nothing developed from this until late in the summer, when the adults migrated northeastward, infesting about 15 townships south of Gildford and Rudyard. The following spring

(1926) a general early hatch took place between April 12 and May 5. This was immediately followed by nine days of continuous cold, cloudy and windy weather which wiped out the infestation (Shotwell 1929).

Throughout the four states mentioned all grasshopper populations reached their lowest ebb in 1927, although that year some late damage to flax, caused by the grasshoppers cutting off the bolls, was reported in Ward County, N. Dak., and damage to seed alfalfa occurred on one farm south of Brockton, Mont.

An early spring survey in 1928 showed eggs of *M. bivittatus* numerous, especially along roadside cut banks facing southward, in Ward and McLean counties, N. Dak., and in soddy headlands in Judith Basin and Chouteau counties, Mont. This same survey indicated eggs of *M. mexicanus* to be numerous along field margins in Chouteau, Valley and Roosevelt counties, Mont. The whole of eastern and northern Montana and western North Dakota was spotted with prospective local minor outbreaks in the spring of 1928. Between May 15 and June 1 a general hatch occurred over the entire area. During this period daily maximum air temperatures ran as high as 96 degrees F. in Montana and 107 degrees F. in North Dakota. In June there followed a period of 10 days to 2 weeks of continuous inclement weather, when daily minimum temperatures as low as 34 degrees and maximums of 52 degrees to 70 degrees occurred. This greatly reduced the infestations in all parts of the territory. In 1929 rains in May and June again held infestations in check.

During the period 1928 to 1930, inclusive, *M. bivittatus* and *M. differentialis* (Thos.) were slowly but steadily increasing in numbers in parts of the Dakotas in spite of adverse weather conditions in May and June. The country was just entering a drought cycle, the days became hotter and there were more hot days each summer although with enough moisture to maintain a succulent cover of vegetation.

In 1931 there occurred in central and southern South Dakota one of the most intense outbreaks of grasshoppers this country has ever witnessed. *M. bivittatus* and *M. differentialis* together destroyed almost all of a luxuriant vegetation, both crop and natural, in an area of 30,000 square miles. These infestations extended into northeastern Nebraska and northwestern Iowa.

In the following two years (1932 and 1933) *M. bivittatus* and *C. pellucida* reached their peaks of greatest abundance in Minnesota and the Red River Valley of North Dakota. During these years *M. differentialis* had done the same in southwestern North Dakota. Then followed heat and drought in the summer and fall of 1933 and in 1934. Under these conditions *M. bivittatus* and *M. differentialis* all but disappeared and *M. mexicanus* became numerous and dominant in North Dakota and Montana. In Michigan and Wisconsin, under the drought existing there during those years, *C. pellucida* increased to enormous numbers in cut-over pasture and stump lands.

There was more moisture in May and June of 1935, and outbreaks, although scattered, were not so destructive. Severe drought prevailed, however, in many places, extending into states normally having a rainfall conducive to a heavy, natural vegetative cover. This enabled local minor populations of *M. mexicanus*, *M. bivittatus*, *M. differentialis* and *M. femur-rubrum* to build up in states that normally do not have severe grasshopper outbreaks. Such states were Oklahoma, Missouri, Arkansas, Illinois, Indiana and Iowa.

In 1936 *M. bivittatus*, *M. differentialis*, and *M. mexicanus* did widespread damage to late crops in these and other states. Colorado and Kansas have not previously been mentioned, but grasshopper troubles occur almost every year in some parts of these states. Most of the trouble in Kansas occurs in the drier western portions, but in 1936 the eastern part suffered severely. The outlook for 1937 was that the outbreaks would be spotted but more widespread than ever, the Panhandle and other parts of Texas being included in the outbreak area. Extreme heat and drought during the summer of 1936 reduced populations of *M. bivittatus* and *M. differentialis*, but *M. mexicanus* was numerous locally in all the states.

POPULATION INCREASES.—One of the common ideas regarding grasshopper outbreaks is that the 'hoppers suddenly appear from some distant source of infestation. There are occasions when *M. mexi-*

Table 1.—Relative abundance, by states, of the species of grasshoppers occurring in the West during the years 1934–1936, inclusive, expressed in percentage of total numbers of specimens collected in each state.

Species	Montana			Wyoming			North Dakota			South Dakota			Montana and North Dakota			Utah		Colorado		Minnesota	
	1934	1935	1936	1934	1935	1936	1934	1935	1936	1934	1935	1936	1926	1927	1928	1935	1936	1935	1936	1935	1936
Acoloplus turnbulli (Thos.)	0.03	0.12	1.27	0.06	1.25	2.78	0.01	0.36	0.53	0.33	2.15	0.54	—	0.17	—	0.34	0.56	6.75	7.77	0.05	—
Agenecotettix deorum (Scudd.)	2.27	7.31	5.75	13.93	3.83	8.37	5.15	15.37	15.25	10.39	19.48	9.52	6.23	10.53	0.21	0.10	0.17	3.99	1.43	7.37	2.53
Amphitornus coloradus (Thos.)	0.33	3.71	0.61	0.18	1.00	0.50	0.19	0.68	0.10	0.51	3.68	0.23	1.19	7.42	—	—	0.25	0.21	0.11	—	1.27
Arphia pseudonietana (Thos.)	0.46	0.21	0.03	0.24	0.41	0.03	0.16	0.16	—	0.28	0.07	0.27	4.90	1.90	6.34	0.49	0.25	0.15	0.40	1.26	0.45
Aulocara elliotti (Thos.)	0.33	6.28	13.36	3.21	2.30	8.50	0.06	1.56	3.19	0.30	4.41	2.42	0.15	3.80	—	0.64	7.94	2.76	1.60	0.05	—
Camnula pellucida (Scudd.)	3.48	2.78	7.52	4.53	20.57	4.23	12.44	5.05	1.49	1.73	1.20	0.55	0.15	0.34	—	7.21	5.18	2.46	1.95	21.43	22.69
Chorthippus longicornis (Latr.)	—	0.25	0.27	—	0.21	0.03	0.37	0.44	—	—	0.18	—	—	1.21	—	2.06	1.32	2.67	0.34	4.18	0.72
Cordillacris crenulata (Brun.)	0.02	4.05	0.58	0.08	0.02	0.13	0.02	0.10	—	0.15	0.44	—	0.30	—	—	—	—	—	—	—	—
Dissosteira carolina (L.)	2.71	0.88	0.83	1.06	0.82	0.38	2.65	6.02	1.72	1.67	2.41	0.49	0.15	0.52	0.42	4.95	1.54	1.78	3.00	4.11	3.53
Drepanopterna femoratum (Scudd.)	0.93	3.67	0.80	5.23	0.62	1.91	0.49	1.47	0.32	3.11	3.83	1.29	0.15	0.34	—	0.29	—	0.49	0.57	—	—
Encoptolophus sordidus (Burm.)	2.22	0.76	0.07	0.38	0.07	0.08	2.19	2.39	0.14	0.76	0.66	0.20	6.82	0.52	7.82	—	—	0.15	0.80	13.19	7.69
Hadrotettix trifasciatus (Say)	0.03	0.15	0.24	0.03	0.14	0.20	0.02	0.16	0.34	0.20	1.93	0.32	0.89	—	—	—	—	1.63	0.51	0.03	—
Hesperotettix viridis (Thos.)	0.16	0.18	0.53	0.57	0.30	0.70	0.32	0.36	0.11	0.09	0.62	0.28	0.15	0.34	—	0.20	0.62	0.58	—	0.21	0.09
Melanoplus angustipennis (Dodge)	0.42	0.53	0.23	1.47	1.53	3.40	2.13	1.92	3.87	4.16	1.17	1.24	0.74	1.73	—	0.10	—	1.78	4.35	0.40	0.69
Melanoplus bivittatus (Say)	1.90	1.66	3.54	6.13	17.88	11.20	2.56	0.72	1.95	2.55	0.51	2.14	—	0.69	—	1.57	7.23	7.34	10.55	12.71	17.95
Melanoplus dawsoni (Scudd.)	1.06	0.33	0.11	0.46	0.09	0.04	1.00	0.42	0.08	0.31	0.04	—	2.67	2.24	6.97	—	0.03	0.06	0.05	6.80	9.62
Melanoplus differentialis (Thos.)	0.14	—	—	0.18	0.25	0.88	1.14	0.63	0.20	6.75	0.22	5.58	—	—	—	0.34	0.03	3.13	3.82	—	—
Melanoplus femur-rubrum (De G.)	18.75	9.60	7.94	16.06	15.69	14.28	9.15	4.20	3.73	2.27	1.71	12.38	0.59	1.55	4.23	22.89	28.45	9.98	17.67	8.55	11.61
Melanoplus gladstoni (Scudd.)	2.84	0.46	0.16	0.64	0.07	0.35	1.65	1.77	0.54	0.49	0.99	0.32	5.34	3.45	40.37	—	—	2.52	0.29	3.05	0.48
Melanoplus infantilis (Scudd.)	4.14	3.41	3.33	2.70	0.41	2.25	0.78	1.87	2.11	0.40	0.15	0.47	5.93	1.90	4.23	—	—	0.55	0.11	0.42	0.93
Melanoplus mexicanus (Sauss.)	42.74	35.75	40.53	25.61	22.94	26.51	42.85	31.21	54.43	38.61	12.73	47.92	14.54	7.94	5.07	26.76	17.44	11.97	16.19	5.99	11.25
Melanoplus packardii (Scudd.)	5.71	4.37	5.69	7.62	3.28	7.06	3.07	4.54	6.15	4.37	2.01	2.77	1.78	1.21	0.48	10.59	13.69	8.17	5.53	0.51	0.06
Metator pardalinus (Sauss.)	0.22	1.24	0.64	0.53	1.73	0.32	0.38	3.64	0.26	0.56	4.05	0.30	1.63	2.76	—	—	—	0.35	0.23	—	0.51
Opeia obscura (Thos.)	0.82	2.14	0.04	0.92	1.25	0.96	1.65	1.57	0.12	0.75	0.81	0.05	12.02	5.01	3.17	—	—	0.52	0.11	0.03	0.03
Orphulella speciosa (Scudd.)	0.25	0.29	0.03	0.03	—	—	0.28	0.11	0.06	0.28	0.26	0.25	—	—	1.48	—	0.08	—	—	3.23	3.89
Philibostroma quadrimaculatum (Thos.)	1.75	1.98	0.37	0.81	0.32	0.66	3.58	5.85	0.78	2.99	4.74	0.45	8.31	5.70	—	—	—	2.73	0.74	—	—
Phoetaliotes nebrascensis (Thos.)	1.31	0.62	0.09	1.78	0.16	0.10	3.10	1.25	0.40	1.94	1.46	1.34	7.86	18.13	11.84	—	—	0.06	—	0.29	—
Spharagemon collare (Scudd.)	0.34	0.26	0.33	0.73	0.59	0.38	0.90	0.83	0.68	0.91	0.99	1.05	—	0.86	—	0.29	0.69	1.47	1.08	0.69	1.18
Spharagemon aequale (Say)	1.29	0.57	0.27	0.84	0.16	0.31	0.05	0.33	0.19	0.48	0.04	0.77	1.93	0.86	0.84	0.74	—	1.57	0.74	—	—
Trachyrachis kiowa (Thos.)	2.57	4.84	1.26	1.45	1.32	0.42	1.29	3.82	0.85	10.55	19.19	1.49	6.23	2.07	3.17	1.03	0.39	1.47	0.17	3.98	1.42
Trimerotropis sp.	—	0.07	0.11	0.08	0.23	0.05	—	0.00	0.02	—	0.12	—	0.15	—	—	16.57	3.26	5.33	0.40	0.03	—

canus has been known to infest, within one season, new territory located 50 to 100 miles distant from its original hatching grounds, and under favorable conditions *M. differentialis* has spread a distance of 100 miles beyond its normal limits. For the most part, however, infestations are of local origin. Probably the main reason for this idea of infestation from a distance is the apparent suddenness of the outbreaks.

Other things being equal, a grasshopper population, from year to year, should increase in geometrical ratio. If an arbitrary factor of increase, such as 6, be selected for a population of 1 grasshopper per unit area of 100 square feet (10 by 10 feet or approximately 11 square yards), the changes in population for this unit area during four years would be as follows: First year, 1 grasshopper per 100 square feet; second year, 6 per unit area; third year, 36; and fourth year, 216. In other words the population for the first three years would be from less than one to approximately three per square yard. To the average person such a change would hardly be noticeable. The fourth year the population would jump to 20 per square yard, which is a heavy infestation. Thus the outbreak has the appearance of sudden development in one year, whereas there has really been a steady geometrical increase in the population for three years. This assumed case is used only as an arbitrary illustration and is not literally factual.

The fecundity of grasshoppers coupled with favorable conditions for oviposition are also important factors in the production of such sudden hordes as occurred in the 1931 outbreak of *M. bivittatus* and *M. differentialis* in South Dakota and the 1937 outbreak of *Dissosteira longipennis* (Thos.) in Colorado. In 1937 relatively uncommon species such as *Boopedon nubilum* (Say), *Dactylotum pictum* (Thos.) *Brachystola magna* (Gir.) and others were found in comparatively large numbers. They seemed to have arisen suddenly over wide areas. The real question is, What happens to the great hordes of grasshoppers which might develop as a result of their fecundity but which seldom materialize? No doubt many factors, such as unfavorable weather, scarcity of food supply, and the work of parasites and predators keep continually reducing populations during all stages of the life cycle. No single factor is of sufficient importance to check population increases, except occasionally, but it is the aggregate effect of all factors that keeps these populations down. The whole problem is a very important one which needs a great deal more detailed study and research than it has yet received.

GRASSHOPPER COLLECTIONS IN TYPICAL ENVIRONMENTS.—In order to obtain information regarding changes in population of the different species of grasshoppers from year to year, collections have been made in typical environments since 1925. At that time grasshopper populations were very low. Collections were made during 1925, 1926 and 1927, but after that the continuity was broken until 1934. That year a definite method for making collections was established for the annual grasshopper survey and has been continued through 1935, 1936 and 1937.

As a part of the survey of adult abundance, representative collections have been made from grasshopper populations in the different habitats found in each state. These were preserved, identified and recorded as to location, character of environment and comparative numbers of each species present. The results of this work have been published as supplements to the Insect Pest Survey Bulletin (Shotwell 1935, 1936 and 1937). In the present paper the data from these reports have been summarized in table 1. Some states are not included because of insufficient material. The collections made in 1926, 1927 and 1928 were not so extensive or detailed as in 1934–1937. They are included, however, to show the changes in the relative importance of some of the major economic species from nonoutbreak to outbreak years.

CHANGES IN RELATIVE ABUNDANCE OF SOME OF MORE IMPORTANT SPECIES.—It would take too long to discuss each species in detail, and a study of table 1 will show any changes in the relative numbers of minor species. In areas planted in crops the five most important species were *M. mexicanus*, *M. differentialis*, *M. bivittatus*, *M. femur-rubrum*, and *C. pellucida*. This applies to all the states except California, which, in addition, has *M. devastator* (Scudd.) and *M. marginatus* (Scudd.) as important species in crops.

| | | |

In the nonoutbreak years, 1926–1928, *M. mexicanus* formed from 5 to 15 per cent of the total number of specimens collected. In the 1931 outbreak in South Dakota and the 1932 outbreak in Minnesota this was a minor species. Beginning in 1933 and continuing through to 1936, this species increased its lead in numbers over the others until, in 1936, it formed 54 per cent of the total number of specimens collected in North Dakota. That year from 60 to 70 per cent of the grasshoppers in small grain, alfalfa and flax were *M. mexicanus*. In the three years 1934, 1935 and 1936 it formed from 39 to 43 per cent of the total specimens collected in Montana, Wyoming, North Dakota and South Dakota and was dominant or important in the other states. In the spring of 1937 one out of five alfalfa fields in Kansas and most of the alfalfa in Nebraska carried moderate to very severe infestations, largely of *M. mexicanus*. It was also the dominant species in most of the other states, where it was numerous along soil-blown fence rows, stubbled-in grainfields, etc.

Partial second generations of *M. mexicanus* developed in western Iowa in 1935 and 1936. The second generation hatched about the first of September and, in 1935, completed the nymphal development and deposited eggs. In 1936 Kansas and Nebraska reported partial second generations of this species. From 1935 to 1937, inclusive, the occurrence of partial second generations of *M. mexicanus* was more widespread and in greater numbers each succeeding year. In 1937 South Dakota, Nebraska, Kansas, Iowa, Missouri and other states had second hatchings of this species in alfalfa and stubblefields, where the populations often ran from 10 per square yard in the field to 100 along the edges. In some places the hatch was somewhat uniform while in others second, third, fourth and fifth nymphal instars occurred with newly molted adults on August 19. This would place the beginning of the second hatch at about July 15 to 20.

As the drought increased, populations of *C. pellucida*, along with *M. mexicanus*, built up in the higher elevations and more northern latitudes. This species reached its peak of abundance in North Dakota, Minnesota, Wisconsin and Michigan in 1934, equaling or exceeding *M. mexicanus* in numbers. In Wyoming the peak was reached in 1935. This same year, in the other states just mentioned, severe infestations of *C. pellucida* hatched out in May and June, but cold, foggy and rainy weather wiped out these outbreaks and reduced the numbers of this species to a minimum. Drought and overgrazing during the years 1931 to 1934 reduced the grass covering on the pastures and haylands to a condition of very short sod ideal for the breeding of this species, while the heavy rains in 1935 produced a heavy growth of weeds on these pastures, thus spoiling them as breeding places and making conditions ideal for bacterial and fungous diseases destructive to grasshopper populations.

M. bivittatus and *M. differentialis* reached the peak of their abundance in South Dakota in 1931 and in North Dakota in 1932 and 1933. In Minnesota *M. bivittatus* became dominant in 1932 and is still a major species. The distribution of *M. differentialis* normally extends northward to latitude 47 degrees in North Dakota, which places its northern limits about 20 miles north of Bismarck. In 1932 and 1933 numerous flights during the long, hot seasons extended its range to Williston, N. Dak., or 100 miles northward and westward of its usual range. On the other hand the range of *M. bivittatus* normally extends into Canada; it is a major economic species in Manitoba. *M. differentialis* cannot establish and maintain itself in these more northern latitudes because its embryonic and nymphal developments require a longer period than those of *M. bivittatus*. *M. differentialis* hatches from two to three weeks later than *M. bivittatus*, and the subsequent nymphal development is from 5 to 10 days longer. Therefore *M. differentialis* requires a longer growing season to complete its life cycle successfully than does *M. bivittatus*. For illustration, in July, 1933, north of Washburn, N. Dak., *M. bivittatus* was observed depositing eggs at the same time *M. differentialis* was still in the sixth instar.

Populations of these two species began to build up in 1928, and this trend continued through to the outbreaks of 1931 and 1932. During these years the weather, although sometimes hot and dry, was wet enough to produce an abundance of food in the form of succulent crops. As the

drought developed in 1933 and 1934 and crops were destroyed, these two species decreased to a vanishing point in the drought areas. Native grasses are better able to withstand dry conditions than are cultivated crops. *M. mexicanus* and *C. pellucida* withstood the drought because they are better adapted to feeding on dry, native grasses than either *M. bivittatus* or *M. differentialis* and therefore supplant them in importance under such conditions. Both these latter species are adapted to areas of cultivated crops and multiply in such places with favorable weather.

In the spring of 1936 *M. bivittatus* and *M. differentialis* were again numerous and destructive in Oklahoma, Arkansas, eastern Kansas, Missouri, eastern Nebraska, western and southern Iowa, Illinois and northeastern Colorado. These were areas of succulent vegetation during 1935 and the first part of the growing season in 1936. Then followed the hottest and driest summer on record. Daily maximum temperatures of above 100 degrees F. occurred, in many parts of the territory, for 17 days in June, 25 days in July, 25 days in August, and even a day or so in the first week of September. Maximum air temperatures of 118 degrees to 121 degrees F. broke all previous records. Some areas went without a drop of rain for over 100 consecutive days. Night temperatures often did not go below 90 degrees F. The 'hoppers ascended trees, shrubs, telephone poles, etc. and remained roosting there completely inactive. Egg deposition on the part of these two species was markedly reduced or delayed, and a large number of adults were actually destroyed by the heat.

Careful observations have shown that the optimum air temperatures for grasshopper activity on the ground are between 75 degrees and 85 degrees F., with surface-soil temperatures under 113 degrees F. Above these temperatures the grasshoppers either take flight or roost in the shade as high off the ground as possible. With air temperatures, during the summer of 1936, remaining above 90 degrees for the greater part of the day and for many days, it is not remarkable that these species took to the trees and remained there. The surveys in 1937 indicated that *M. mexicanus* had supplanted these two species in importance. Grasshopper damage to corn in 1937 was considerably less than in 1936. Both *M. bivittatus* and *M. differentialis* do more damage to corn than any other species, and this lessening in damage to corn was a fair indication of a reduction in numbers of these two species.

M. femur-rubrum has always been an important species during outbreak years, especially in alfalfa and sweetclover, where it is often dominant. One of the important changes in the relative abundance of the different species that has occurred was the increase of this species in the period 1935–37 in Wisconsin, Minnesota, Iowa, South Dakota, Colorado and Utah, and perhaps elsewhere. In 1936 it formed 65 per cent of the total specimens collected in Wisconsin, 12 per cent in Minnesota, 12 per cent in South Dakota, 18 per cent in Colorado and 28 per cent in Utah. In eastern Iowa it was the most numerous species, and in southern Minnesota and Wisconsin it was the most destructive. Again in 1937 *M. femur-rubrum* became a problem in southern Wisconsin and parts of Minnesota and Iowa.

M. packardii has been widespread and often numerous enough to be considered important. *Ageneotettix deorum* has also been an important species in all of the states east of the Continental Divide. It is widely distributed in small grains, field margins, legumes, and grasslands. In 1936 it increased its lead over other species in the range lands of North Dakota, exceeding even *M. mexicanus* in numbers.

Of the range-land and pasture grasshoppers, the important species have been *Ageneotettix deorum*, *Encoptolophus sordidus*, *Trachyrachis kiowa*, *Aulocara elliotti*, *Cordillacris crenulata*, *Melanoplus infantilis*, *Phlibostroma quadrimaculatum*, *Drepanopterna femoratum*, *Amphitornus coloradus*, *Aeoloplus turnbulli* and, last but not least, *Dissosteira longipennis*. *Encoptolophus sordidus* has been numerous in Michigan, Wisconsin, Minnesota and eastern North Dakota. During 1935 and 1936 *Aulocara elliotti* increased both on the range and in the small grain, in Montana and elsewhere. On the range, in Montana in 1936, it supplanted *C. crenulata*, which dropped from first place in 1935 to eighth place in 1936. *Amphitornus coloradus*, *P. quadrimaculatum* and *M. infantilis* have fallen off in numbers. An-

other common and abundant species in 1926–1928 was *Phoetaliotes nebrascensis*. It is usually found in lowlands where the vegetation is lush. It has also fallen off during the drought years. *Dissosteira carolina* is ever present, usually along hot, dusty roads, and sometimes becomes important. *Aeoloplus turnbulli* was numerous in Colorado and elsewhere in 1936 on the more open and bare ground.

Over a large area embracing the southeastern quarter of Colorado, the southwestern portion of Kansas, the Panhandle of Oklahoma and six or eight counties in the extreme northwestern part of the Texas Panhandle, *Dissosteira longipennis* recently increased to enormous numbers on the range lands. In the spring of 1937 populations of this species numbered as high as 50 to 500 newly hatched nymphs per square foot over areas from 80 to 320 acres in size. In the Texas Panhandle it has proved a menace in the fall to newly sprouted winter grain. With such a large area involved and populations so dense, this species proved a real problem in 1937. A survey of the outer limits of extreme distribution of this species showed it to extend as far north as Torrington, Wyo., and Alliance, Nebr., then southeastward to Ogallala, Nebr., and eastward to Salina, Kans., southwestward to the Panhandle of Texas, and as far south as Amarillo, Tex. The Rocky Mountains formed the western boundary of distribution.

Other states not included in this discussion but that have had grasshopper outbreaks are Arizona, California, New Mexico, Nevada and Oregon. In Arizona *Melanoplus mexicanus*, *M. bivittatus*, *M. femur-rubrum* and *M. differentialis* are the important species. Based on their injury to cultivated crops and grazing land in California, *Camnula pellucida*, *M. mexicanus*, and *M. devastator* are about equally important, with *M. marginatus* and *M. femur-rubrum* second and *M. differentialis*, *Oedaleonotus enigma* (Scudd.), *O. borckii pacificus* (Scudd.), and *Hippiscus californicus* (Scudd.) of somewhat less importance. *Melanoplus devastator* inhabits the foothills of the coast and inland ranges of the Sierra Nevada (Wilson 1936). *Camnula pellucida* has been most important in Oregon, with *M. mexicanus* and *M. femur-rubrum* in localized infestation. In Nevada *C. pellucida* is the important species, and in New Mexico *M. bivittatus*, *M. differentialis* and *M. femur-rubrum* are dominant.

This concludes the discussion of the more important species responsible for grasshopper outbreaks. For further detailed study of the species, an examination of table 1 will reveal the changes that may have taken place in the relative abundance during the period 1934–1936.

CHANGES IN THE AREAS OF NATURAL VEGETATION IN RELATION TO GRASSHOPPER POPULATIONS.—It is important that something be said regarding the changes in the areas of natural vegetation that are connected with grasshopper outbreaks. There are nine general areas of natural vegetation in which studies of the fluctuations of grasshopper populations are being systematically conducted. These are the northeastern pine forests and northeastern and southern hardwood forests of Wisconsin and Michigan; the tall-grass prairies, embracing parts of Minnesota, Iowa, North Dakota, South Dakota, Nebraska and Kansas; the short-grass prairies or plains grasslands of the Dakotas, Nebraska, Kansas, Colorado, Wyoming and Montana; the foothills of South Dakota and of the Rocky Mountain states; the montane and alpine meadows of the Rocky Mountain states; and the northern desert-shrub or sagebrush areas of Wyoming, Utah and Idaho. These terms describe the original ecologic conditions that prevailed before the white man came.

The forests of Wisconsin, Michigan, and Minnesota have been denuded by great lumbering operations, leaving a waste of cut-over stumps and pasture land which, because of overgrazing and drought, provided ideal breeding grounds for the increase of *Camnula pellucida* and *Melanoplus mexicanus*. Most of the original vegetation of the tall-grass prairies has been replaced by cultivated crops, introducing fence rows, roadsides, pastures and certain crops ideal for grasshoppers under dry conditions. The short-grass areas have been broken up into cultivated small grain, corn and alfalfa fields, furnishing succulent foods for such species as *M. bivittatus*, *M. differentialis* and *M. mexicanus*.

With the introduction of agriculture have come the idle lands and stubblefields ideal for the building up of *M. mexicanus*. Sixty per cent of the total numer of speci-

mens collected in idle lands in North Dakota and Montana in 1936 were *M. mexicanus*. The Russian thistle (*Salsola pestifer*) was introduced into the Great Plains area along with agriculture and is the most abundant and widespread of all the plants thus brought in. Drought years are favorable for the increase of this plant, and it is the first to appear on idle or abandoned lands and occurs along field margins and in stubble land. In the spring the newly sprouted Russian thistles furnish food for the newly hatched grasshoppers, especially *M. mexiacnus*. The old dried thistles that have collected along the fence rows and in the stubble or pastures furnish excellent shelter and protection for the nymphs during unfavorable periods. Therefore this plant has been a great help in maintaining grasshopper populations. *M. differentialis* was a minor species along river courses until the introduction of more extensive areas of succulent plant food in the form of grain and legumes. It was then enabled to move to the uplands, where it found food conditions ideal during years favorable for its increase. With the introduction of alfalfa and the grazing of small pasture, ideal breeding places have been established for all the species, and more especially for *M. mexicanus* and *M. femur-rubrum*.

Of late years in some of the "dust-bowl" areas, soddy headlands formerly favorable for egg deposition by *M. differentialis* and *M. bivittatus* have been covered and the sod killed out by drifting soil, leaving soil-blown fence rows covered with Russian thistle. In the spring of 1937 these headlands produced an abundance of *M. mexicanus* and it is a question what will eventually happen to the grasshopper fauna in these places.

In all these areas of natural vegetation man has, of course, disturbed the balance of nature in the original flora by his farming and grazing practices and by the introduction of new plants. This has had its effect on the grasshopper fauna. Changes in the relative abundance of species are rapid. One year a certain species may be very numerous and even dominant and in the next year or two it may practically disappear. The increase in numbers of grasshoppers is partly due to these introduced food plants, largely crops and mostly annuals, which in turn are more susceptible to weather changes than the fully adapted native plants. Therefore the many and varied farming and grazing practices have promoted instability among the species of grasshoppers. In severe outbreaks grasshoppers tend to increase in numbers far beyond the carrying capacity of the plant food present in an area. This causes a shortage of food and may suddenly reduce the population. Other factors, such as heat and drought, also help in reducing the carrying capacity to much lower levels than normal and thus aid in the reduction of populations. All of these factors are directly responsible for the changes, observed from year to year, in the relative abundance of the different species of grasshoppers.

SUMMARY.—From 1928 to 1931, inclusive, *Melanoplus bivittatus* and *M. differentialis* steadily increased in numbers until in 1931 they staged the worst outbreak in the history of South Dakota. From 1933 to 1935 severe drought conditions prevailed and reduced the populations of these two species. During this same period *M. mexicanus* increased until it reached its peak of abundance in 1934. Outbreaks of grasshoppers under dry conditions have spread to states not normally having severe grasshopper outbreaks. Drought has a tendency to reduce populations of some species, whereas others are better able to withstand such conditions because they can survive on the drier native grasses. Changes in weather, food plants and plant cover from year to year effect changes in the relative abundance of the different species of grasshoppers.—2-14-38.

LITERATURE CITED

Cooley, R. A. 1925. Summary of the grasshopper experiences during the past two years. In twentieth report of the state entomologist. Univ. Mont. Ag. Exp. Sta. Bul. 170: 13–9.

Shotwell, R. L. 1929. Some notes on the grasshopper situation in north central Montana. JOUR. ECON. ENT. 22(3): 581–8. June.

Shotwell, R. L. 1935. The species and distribution of grasshoppers responsible for the 1934 outbreak. Insect Pest Survey Bul. 14(9, Suppl.): 229–327. (Mimeographed.)

Shotwell, R. L. 1936. The species and distribution of grasshoppers in the 1935 outbreak. Insect Pest Survey Bul. 16(5, Suppl.): 213–59. July 15. (Mimeographed.)

Shotwell, R. L. 1937. The species and distribution of grasshoppers in the 1936 outbreak. Insect Pest Survey Bul. 17(3, Suppl.): 117–50. May 15. (Mimeographed.)
Wilson, C. C. 1936. Special report grasshopper egg survey in California, 1936. (Unpublished report.)

Experiments With Phenothiazine and Mosquito Larvae

W. V. KING, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

From tests conducted by Bulger in 1934, phenothiazine (thiodiphenylamine) was reported by Campbell *et al.* (1934) as being toxic for *Culex* larvae in the high dilution of 1 to 1,000,000, and attention was directed to this organic compound as a promising new insecticide. In the original experiments the material was dissolved in acetone before dilution in water.

Further tests of its effect upon mosquito larvae have been made by Mail (1936), who reported that its addition to petroleum oil increased the toxicity of the oil to some extent. From a considerable number of experiments upon various plant-feeding insects, a review of which has been prepared in mimeograph form by Smith (1937), encouraging results have been reported against some species but negative results against others. So far as shown in this review, the chemical was applied as either a water suspension or a dust. Various materials employed as stickers were added in some instances. Tests on rats, rabbits and man have indicated that the chemical is practically nonpoisonous to warm-blooded animals.

PREPARING THE MATERIALS.—Phenothiazine is insoluble in water, and a suspension in water was found to be difficult to prepare, as the material is resistant to wetting. Moreover, the undissolved material proved to be considerably less toxic for mosquito larvae than an acetone solution. After some experimentation with wetting agents and solvents in an effort to develop a practical method of preparing the material for field tests, promising results were obtained with a commercial brand of sulfonated petroleum oil. The phenothiazine mixes readily with this, and the oil in turn is miscible with water. Mixtures of 1 part (grams) of phenothiazine in 20 and 40 parts (cubic centimeters) of the oil proved to be toxic in rather high dilutions for *Culex* larvae. Somewhat quicker killing occurred when the mixture was allowed to stand 24 or 48 hours before being diluted.

The most effective preparation, however, was obtained by adding a small amount of acetone to the oil and phenothiazine and diluting this solution in water before the acetone evaporated.

The amounts of material used in preparing the solution were 0.05 gram of phenothiazine, 1 cubic centimeter of sulfonated oil and 0.25 cubic centimeter of acetone. After thorough mixing, 20 to 30 cubic centimeters of water were added, while the mixture was being stirred, to form the stock solution. For the first dilution this was made up to 500 cubic centimeters, from which 5 and 10 cubic centimeter quantities were pipetted out for the final dilutions in 1 liter of tap water. This gave a flocculent, slightly yellowish suspension that did not show visible settling after several hours. Dilutions having a milky-white color indicate undue loss of acetone by evaporation during the preliminary stirring and show a consequent loss of toxicity; so this part of the operation should be hastened or the amount of acetone increased slightly. Too large a proportion of acetone, however, causes a curdling or a separation of the oil upon the addition of water, and such preparations were discarded.

LABORATORY EXPERIMENTS.—In a series of laboratory tests of this combination, conducted at Orlando, Fla., the larvae were killed, usually within a few hours, at phenothiazine dilutions of 1–1,000,000 and 1–2,000,000. The average killing times were 1.36 hours at 1–1,000,000 and 2.08 hours at 1–2,000,000. With acetone solutions a very much larger proportion of the solvent was required, to avoid precipitation of the phenothiazine on the surface of the water, and the degree of toxicity was somewhat lower. The average killing time at 1–1,000,000 was 1.53 hours, while at 1–2,000,000 the mortality usually

was not complete. No mortality occurred in the check dishes or in control tests in which corresponding amounts of oil and acetone only were employed.

Commercial phenothiazine that was of 99 per cent purity was used and most of the tests were run in 1 liter of water containing 20 fourth-stage larvae of *Culex quinquefasciatus* Say. The water temperatures ranged from 68 degrees to 72 degrees F. The larvae were obtained from breeding tubs exposed in the laboratory yard and were considered to be representative of natural field material. In this connection, however, mention should be made of an observation from which it was indicated that the previous diet of the larvae might affect materially the results of such tests. In two experiments with larvae of the same species, which had been reared on a concentrated diet of yeast and dried blood, a mortality of only about 50 per cent occurred when a phenothiazine dilution, from acetone, of 1–1,000,000 was used. These larvae had been reared for experimental purposes and were supplied by the Division of Control Investigations. When larvae from the same source had been kept in clear water overnight, their susceptibility to the poison was not noticeably different from that of specimens from the tubs.

A few tests of phenothiazine solutions, prepared with sulfonated petroleum oil and acetone, have been made in storm-sewer catch basins that were filled with more or less polluted water and contained large numbers of *Culex* larvae. Applications at the rate of 1–500,000 gave a high percentage of mortality under such conditions. While much more experimental work, in comparison with larvicides now in use, will be required to determine whether the material has a possible field of usefulness in practical antimosquito work, it seems desirable to report the results of the laboratory experiments at this time and to describe the method of preparation found to be most effective for these insects.

SUMMARY.—Of several preparations of commercial phenothiazine that were tested on larvae of *Culex quinquefasciatus* Say, the most effective was a solution consisting of 1 part (grams) of the phenothiazine in 20 parts (cubic centimeters) of sulfonated petroleum oil and 5 parts (cubic centimeters) of acetone. The solution is mixed with water, with which it is readily miscible, before evaporation of the acetone occurs. In laboratory experiments with larval material reared under natural breeding conditions the phenothiazine was fatally toxic at dilutions of 1–2,000,000. Larvae that had been reared on an artificial diet of yeast and dried blood, however, were much less affected by the poison until after they had been removed from the food medium for several hours.—3-3-38.

LITERATURE CITED

Campbell, F. L., W. N. Sullivan, L. E. Smith and H. L. Haller. 1934. Insecticidal tests of synthetic organic compounds—chiefly test of sulfur compounds against culicine mosquito larvae. JOUR. ECON. ENT. 27(6):1176–85.

Mail, G. A. 1936. Thiodiphenylamine—a new ingredient of mosquito larvicides. JOUR. ECON. ENT. 29(6):1144–6.

Smith, L. E. 1937. The use of phenothiazine as an insecticide. U. S. A., Bur. Ent. and Plant Quar. Mimeographed. Circ. E-399. 11 pp.

Effects of Acidity, Alkalinity and Moisture Content of the Soil on Emergence of *Cochliomyia americana* C. & P.

ROY MELVIN and R. C. BUSHLAND, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

It has been demonstrated that in swampy areas during wet years the population of *Cochliomyia americana* C. & P. has been very low, and there has been considerable speculation about the cause of this condition. The purpose of the investigation reported in this paper was to evaluate, by means of laboratory tests, the effects of acid and alkaline conditions and the moisture content of

the soil on the emergence of *C. americana*.

METHOD OF TESTING.—White sea sand was treated with dilute sulfuric acid, washed with tap water until acid-free, and thoroughly dried. Tall-form, pint Mason jars were then exactly half filled with this sand, to which were added measured amounts of sulfuric acid, potassium hydroxide and distilled water. Eighty-two cubic centimeters of water are required to saturate completely this measured quantity of the sand. Thus the degrees of saturation listed refer to definite volumes, as follows: Saturated, 82 cubic centimenters; seven-eighths saturated, 71.75 cubic centimeters; three-fourths saturated, 61.5 cubic centimeters; one-half saturated, 41 cubic centimeters; and one-fourth saturated, 20.5 cubic centimeters.

The potassium hydroxide use in this test was titrated against two lots of standard hydrochloric acid, obtained from different sources. All normalities given are correct to at least two decimal places.

After the solutions had been thoroughly mixed with the sand, 100 mature larvae were placed in each jar, four jars at each condition. The jars were covered with screen lids and replaced in their boxes, and the boxes placed in a cabinet containing open pans of water so that the relative humidity was held close to 100 per cent. The temperature was not constant but averaged around 80 degrees F. Counts were made after the flies had emerged and died.

RESULTS OF TESTS.—The results of two tests, one initiated February 8, 1937, testing acid tolerance of larvae (twenty-second generation reared on artificial media*), and the other initiated March 8, testing alkaline tolerance of larvae (twenty-fourth generation reared on artificial media), are combined in table 1. It should be stated here that results of preliminary tests indicate that animal-reared larvae are but slightly more resistant to these adverse conditions than are the larvae reared on artificial media.

Table 1.—Effect of potassium hydroxide, sulfuric acid, and moisture content of sand on emergence of *Cochliomyia americana* C. & P.

Solution Applied	Per Cent Emergence from Larvae Dropped in Sand				
	¼ Saturated	½ Saturated	¾ Saturated	⅞ Saturated	Saturated
Test of March 8, 1937; 400 larvae (24th generation on artificial media) at each condition; pupal weights approximately 50 mg.					
4.00 N KOH	10.75	5.25	0.00	0.00	0.00
3.00 N KOH	10.25	4.75	0.00	0.00	0.00
2.00 N KOH	17.00	9.00	0.00	0.00	0.00
1.00 N KOH	47.50	22.00	2.75	0.00	0.00
0.50 N KOH	62.75	30.00	8.75	3.75	0.50
0.25 N KOH	84.75	70.50	48.75	30.50	7.25
Distilled water	96.75	94.50	88.25	78.00	62.75
0.05 N H_2SO_4	83.25	73.50	58.25	39.50	29.50
Test of February 8, 1937; 400 larvae (22nd generation on artificial media) at each condition; pupal weights approximately 45 mg.					
Distilled water	92.50	88.75	78.25	60.25	54.00
0.05 N H_2SO_4	76.25	63.75	51.00	50.50	34.00
0.10 N H_2SO_4	65.25	37.75	29.75	18.00	10.00
0.20 N H_2SO_4	50.00	23.25	15.75	4.25	2.25
0.40 N H_2SO_4	22.50	2.25	0.00	0.00	0.00
0.50 N H_2SO_4	7.75	0.50	0.25	0.00	0.00
1.00 N H_2SO_4	0.25	0.00	0.00	0.00	0.00

It will be noted from the table that as the moisture content of the sand increased the emergence of flies was correspondingly reduced. It was noted that in the saturated jars only those larvae pupating on top of the sand produced flies. Pupae buried under 1, 2 and 3 inches of saturated sand (400 at each level) failed to produce flies, while good emergence was secured in the controls.

CONCLUSIONS.—Larvae of *Cochliomyia*

* These media were modifications of those described by R. Melvin, and R. C. Bushland, 1936. A method of rearing *Cochliomyia americana* C. & P. on artificial media. Diptera. U. S. D. A. Bur. Ent. and Plant Quar., Mimeo. Cir. ET-88.

americana C. & P. can withstand greater concentrations of potassium hydroxide than of sulfuric acid, but their great tolerance to both chemicals indicates in general that, in nature, the alkalinity and acidity of the soil are factors of negligible importance on the emergence of adults.—3-5-38.

An Unusual Type of Top-Kill of Ponderosa Pine

K. A. SALMAN, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine*

During 1935 an unusual type of insect attack on the tops of ponderosa pine trees was prevalent in several forested areas in California. In most of the areas in which the injury was noted in 1935, little or no new injury could be found in 1936. However, a limited amount of the same type of damage was seen in several new areas. Typical examples of the damage are illustrated in fig. 1, which shows injured trees on a cut-over area near Whitehorse on the Modoc National Forest. Two species of *Pityophthorus* seemed to be primarily responsible for the injury.

DISTRIBUTION OF THE INJURY.—The injury was first noticed in 1935 near Whitehorse. No new attacks were found in that area in the following year. The top-killing was not confined to cut-over stands, as it also occurred in virgin timber nearby. Similar injury was observed in virgin stands on the Plumas National Forest in 1935. In 1936 a considerable amount of the same type of top-killing was seen on recently cut-over lands in Squaw Queen Valley on this forest. The stands had been logged late in 1935, or were in the process of being logged during 1936. A small amount of injury was noted in 1936 in second-growth stands along the road from Marysville to Camptonville.

In 1935 top-killing was very prevalent in some stands on the Stanislaus National Forest. J. E. Patterson of the Berkeley laboratory, Bureau of Entomology and Plant Quarantine, observed the injury and collected specimens from cut-over lands near Pinecrest on that forest. W. W. Wagener, of the Office of Forest Pathology, Bureau of Plant Industry, also collected specimens from trees in the vicinity of Jenness Mill on the same forest. Although Mr. Patterson observed some recently injured trees in the same general area in 1936, they were much less abundant than during the previous season.

G. R. Struble of the Berkeley laboratory reported that 1935–36 overwintering broods of *Pityophthorus* were present in two-thirds of the upper crown of a ponderosa pine that was attacked by 1936 broods of the western pine beetle, *Dendroctonus brevicomis* LeC. In his opinion the *Pityophthorus* attack was primary and preceded attacks by the other species.

A similar type of injury was observed in parts of the Sierra National Forest in 1936. Examination of a tree in which the killing had advanced for some distance down the bole revealed the presence of broods of *Ips confusus* (LeC.) in the top. In other trees, in which the damage was confined to the extreme tip, it is probable that *Pityophthorus*, and not *I. confusus*, was responsible for the injury.

CAUSE OF THE INJURY.—Samples of infested material were obtained by felling injured trees, and attempts were made to diagnose the conditions that induced the infestation. Examination of the infested trees showed that species of *Pityophthorus* were, with few exceptions, the only ones concerned. Specimens sent to M. W. Blackman, then of the Division of Forest Insect Investigations, Washington, D. C., were determined by him as *P. confinis* LeC. and *P. confertus* Sw.

So far as is known, these species have not been recorded heretofore as causing this type of injury. However, observations have indicated that the damage, although perhaps more prevalent and widespread during 1935 and 1936, is not of rare occurrence. Trees having small stag tops were seen in several of the infested areas, and apparently these top injuries are the result of old *Pityophthorus* attacks.

HABITS OF THE SPECIES CAUSING THE DAMAGE.—*P. confinis* has been reported by Blackman (1928) to occur in seven western states and in British Columbia. He lists ponderosa, Jeffrey and Coulter pines as hosts and indicates that pon-

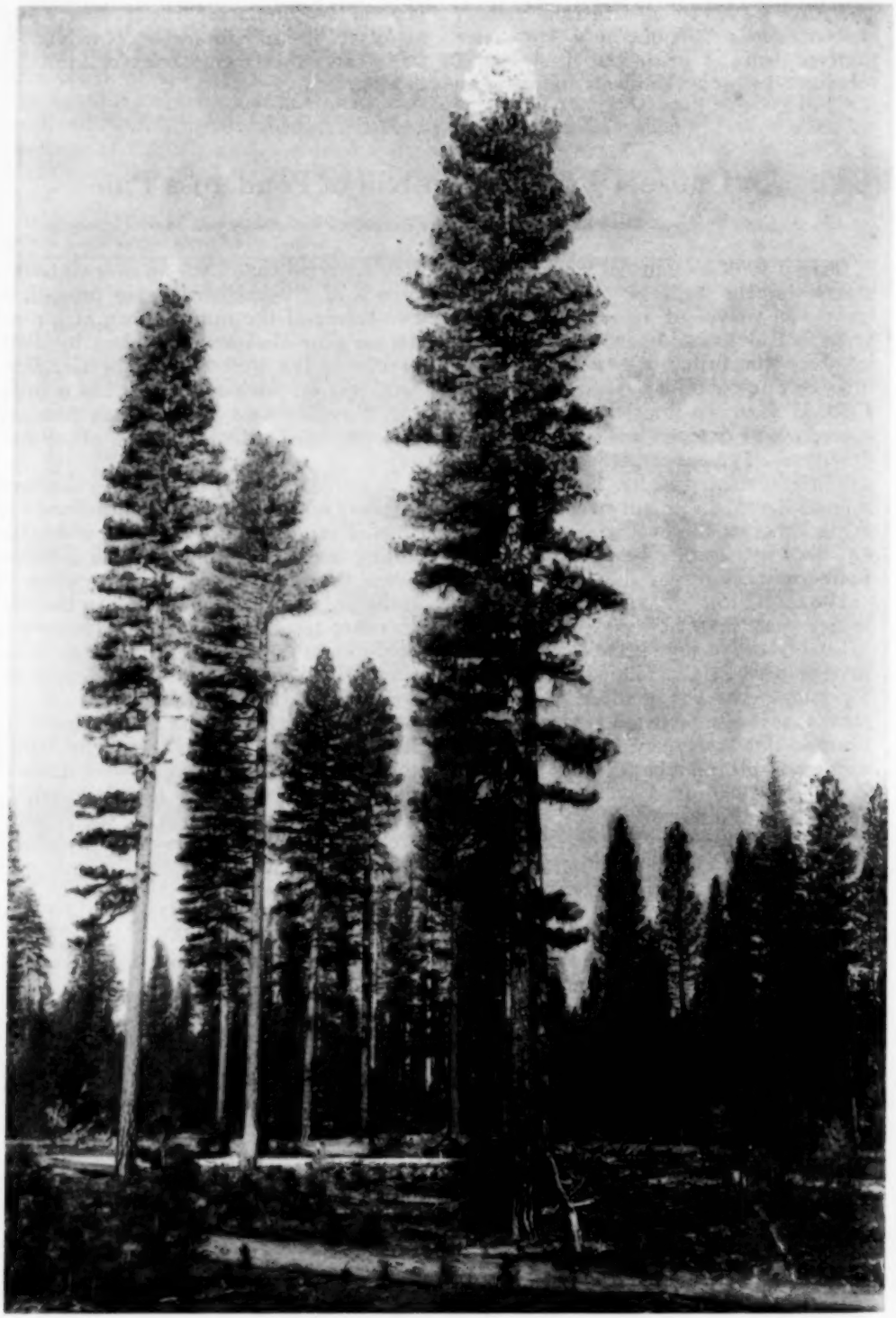

FIG. 1.—Large trees infested by *Pityophthorus* on a cut-over area in the Modoc National Forest, near Whitehorse, Calif.

derosa pine is the favorite. He states (p. 67) that this species "may attack either living twigs or twigs which have been injured by various causes."

Records of collections of *P. confinis* from ponderosa pine by workers at the Berkeley laboratory indicate that the species may also infest the trunks of mature trees, poles, and reproduction. *P. confinis* has been taken from the tops of trees infested by other species of bark beetles. It has been taken from twigs, limbs and main stems of reproduction, and from poles in which that species and *P. hopkinsi* Blackman occurred together. One record notes that *P. confinis* infested branches the needles of which were heavily infested with *Aspidiotus pini* Comst. It has not previously been recorded that *P. confinis* attacks the boles of otherwise uninfested or uninjured trees.

P. confertus has been recorded by Blackman (1928) from the same general area from which *P. confinis* has been taken. He lists nine species of pine and three species of fir as hosts. In records of collections from ponderosa pine at the Berkeley laboratory there is no indication that this species has ever been taken from otherwise uninjured or uninfested trees. Specimens have been obtained from limbs and trunks of trees infested by other species of bark beetles and from logging slash. There is one record of the occurrence of *P. confertus* in a top-killed tree in which three species of *Ips* were also present. It is probable that the engraver beetles initiated the attack on this tree.

In several records *P. confinis* and *P. confertus* have been noted as infesting the same or different portions of the same tree. The latter species seems to have a definite preference for the larger branches or for portions of the bole.

CHARACTERISTICS OF THE INFESTATION.—In most areas the infested trees were some of the thriftiest in the stand. On cutover areas they were the trees that, because of their evident vigor, had been selected to form the basis for a new crop of timber.

Both species were collected in the spring of 1935 on the Modoc National Forest from material that had been attacked late in the previous season. Both species were obtained from limbs and portions of the main stem, and it was apparent that neither species was confined to any particular portion of the infested bark areas. On one tree both species were recovered from infested bark on the trunk of a tree at a point at which it was about 5 inches in diameter. *P. confertus* was the only species collected on the Stanislaus National Forest.

The attacks by *Pityophthorus* appeared to be normal. The usual stellate brood burrows were formed, and the few larvae that had not completed their development appeared to be normal in size. The presence of teneral adults in the collections showed that the broods had been successful. No pitch tubes were formed, and only a few attacks were pitched out and unsuccessful. The bole of each tree that was felled was examined for evidences of infestation by other species of insects, for porcupine feeding scars, logging injuries or for other abnormal conditions that might have weakened the trees. No injuries other than those resulting from the *Pityophthorus* attacks could be observed.

In only one of the trees could any visible cause, other than the *Pityophthorus* infestation, be found for the injury. In this tree *I. confusus* was responsible for the top-killing. The *Pityophthorus* infestations were widespread and occurred in markedly different environments. They were present in stands of varied composition, character and general vigor. They were found in both virgin and cutover stands. The thriftiest trees seemed to be selected for infestation to a greater degree than the less thrifty trees. *Pityophthorus* infestations appeared to be the primary cause of most of the injury, although it is possible that the trees had previously been weakened and their resistance to insect attack reduced by some other environmental factor. If such was the case, that factor could not be determined.

COMPARISON WITH OTHER TYPES OF TOP-KILLING.—Top-killing as a result of insect attack is of common occurrence in the pine forests of California. In fact, recent studies by the author have shown that complete infestation of ponderosa pine trees often follows initial attacks in the tops. Attacks by *Melanophila californica* Van D. and *Ips oregoni* (Eichh.), which result in the top-killing of trees, are very common in northeastern California. *M. californica* and *I. confusus* cause similar injury to ponderosa pine in many

areas on the western slope of the Sierra Nevada. The last named species is responsible for sporadic outbreaks in those areas in which injury to the tops of trees is a predominating feature in bark-beetle infestations.

The type of injury caused by *Pityophthorus* was unlike that caused by most of the other species. When the *Pityophthorus* infestation extended downward for some distance from the tip of the bole, the injury was in some respects similar to that sometimes caused by *I. confusus* or *I. oregoni*. In those trees the foliage on branches along the infested portions of the bole faded evenly. In most of the trees observed, a sharp line of demarcation occurred between the green of unaffected foliage and the sorrel or reddish color of foliage on branches in the infested portions. When *Ips* attacks are not followed by supplementary infestations, a similar condition results.

When *Pityophthorus* attacked only a foot or two of the extreme tip, the infested portion was the only part that died. There is no other common insect-caused injury having a similar appearance that is known to occur on large ponderosa pine trees in California.

When caused by other species of insects, top-killing is often followed by supplementary attacks, below the areas of original infestation. Usually this spread of infestation continues until the greater portion of the bark area of the bole is infested. In some trees this has already occurred as a result of the more extensive attacks by *Pityophthorus*. Attacks of less severity have resulted in little more than the formation of a small stag top.—3-11-38.

LITERATURE CITED

Blackman, M. W. 1928. The genus *Pityophthorus* Eichh. in North America. N. Y. State Col. For. Syracuse Univ. Tech. Pub. **25**: 1–159. 11 pl.

Mothproofing Preparations and Methods of Testing

SAMUEL C. BILLINGS, *U. S. Department of Agriculture, Food and Drug Administration*

During the last few years there has been a large increase in the number of commercial mothproofers of various types on the market. The Food and Drug Administration, pursuant to the Insecticide Act of 1910, has examined about 300 of these products and the results of this work are presented here briefly.

COMPOSITION.—These materials are of two general classes: The first consists of inorganic salts dissolved in water, and the second of more or less complex organic substances carried in a light petroleum fraction or other organic solvent.

The water-soluble mothproofers generally contain a compound of arsenic or fluorine as the active ingredient. Sodium arsenate, sodium arsenite, sodium fluoride, sodium fluosilicate, magnesium fluosilicate and the corresponding potassium salts are the ones most frequently encountered. They may be marketed either in solution or in dry powdered form. The toxic ingredient is usually present in amounts ranging from one-fourth of 1 per cent to 1 per cent in the solution when prepared for use. Alum, sodium sulfate and other materials are frequently found as auxiliary substances. When woolens are thoroughly impregnated with proper solutions of these fluorine and arsenical compounds the mothproofing valued is unquestioned. Washing in soap and lukewarm water usually reduces or destroys their efficiency, but drycleaning in the usual solvents, ironing and long exposure to sunlight do not appear to have any appreciable adverse effect on the mothproofers of this type. It should be borne in mind that these substances are poisonous and their use in clothing has been condemned by some authorities.

In using the organic compounds thorough application to the article to be protected is necessary and even then at least one-third of all materials in this group appearing on the market have been found lacking in mothproofing value. Dry cleaning and long exposure to sunlight reduces the value of many of those that are otherwise effective.

TESTING.—Since moth damage is

caused by the feeding larvae which do not ordinarily migrate far from the places where hatched, the eggs are a logical starting point for the testing of mothproofing products. The method we employ is as follows: A large piece of woolen cloth is treated with the "mothproofing" solution according to label directions and allowed to dry. Part of this is cut into pieces about 2 by 5 inches and to some of these is added a small quantity of dry brewers' yeast (Colman 1932) which is gently rubbed into the cloth. Others are used without yeast treatment. Ten to 20 eggs of the webbing clothes moth, *Tineola biselliella* (Hum.), are placed on each piece. These pieces of cloth are folded so that the eggs are between the layers and then placed individually in cylindrical friction-top cans $2\frac{3}{8}$ inches in diameter by $1\frac{1}{2}$ inches deep.

The number of tests made on any particular material varies but, in general, a total of eight tests is adequate. About half are run without yeast treatment. The tins are closed and placed in a warm (75–80 degrees F.), dry place for a period of at least 40 days. However, if the product is ineffective in preventing moth development, the yeasted tests will usually show development by the twenty-fifth day from start of the test. This method also involves hanging a portion of the original treated woolens in a moth-infested room. The adult moths in due time deposit eggs on such woolens, and moth injury will develop if the product is ineffective.

If the mothproofing material is one that may deteriorate with age or on exposure to light, tests are made also by exposing the treated fabric to either aging or light before the eggs are placed on it.

Check tests on untreated woolens with and without yeast are always run at the same time. In the case of the checks and those tests with ineffective materials, the feeding and development of the larvae are much slower on the unyeasted woolens than on the yeasted; also, a higher natural mortality occurs on the former. However, tests on yeasted and unyeasted woolens have always been found concordant. Yeast alone is not a sufficient food for this moth. In some cases larvae are used in place of the eggs and such tests are run in the same manner save that the test period may be somewhat curtailed.

The eggs of the casebearing clothes moth, *Tinea pellionella* L., can be used also, but only in connection with yeast or some other supplement, since it appears, so far as woolens are concerned, that this insect derives a large portion of its nutriment from contamination on the fabric. Larvae started on yeasted woolens can subsequently feed on clean unyeasted woolens to a variable degree. The larger ones placed on clean woolens may produce fairly normal adults, but the smaller will not complete their development or they will produce undersized adults. When heavily yeasted woolen goods in quart jars at about 80 degrees F. are used, the life cycle of this insect is about 70 days and, except for prolonging the test period to 40 days, the work may be conducted as with the other species. The eggs are fragile and must be handled with care. The newly hatched larvae appear to be more easily killed than those of *T. biselliella* when tested by the egg method. Casebearing larvae of various ages can be employed also for test purposes.

Conclusions in all cases should be based primarily on the extent of the moth injury on the treated cloth. Efficient mothproofers should prevent all moth injury under the methods of examination involving eggs.

Two precautions are to be observed with these methods. The woolen goods should be carefully checked in advance to determine its suitability, since these materials vary greatly in their susceptibility to moth damage. The untreated woolens when supplemented with yeast should support freely both species of moths through their entire life cycles. It has been found desirable to autoclave the yeast dry for about one hour at 120 degrees C., as indicated in a previous article (Billings 1936).

The treated fabric should be thoroughly dry before it is subjected to tests. This is especially important in connection with certain mothproofers in which the solvent is a light fraction of petroleum. Tiny droplets of the solvent oil may remain on the fibers for several weeks after treatment and kill by contact any larvae or eggs place thereon, giving the impression that the fabric is mothproof, which may or may not be correct. If the oil solvent has completely evaporated from the fabric before it is tested, the same results are obtained whether it is tested in open or

closed containers. Therefore, a fumigating effect from the solute on the fibers is not to be expected in closed containers—3-18-38.

LITERATURE CITED

Billings, S. C. 1936. Notes on clothes moth breeding. JOUR. ECON. ENT. 29(5):1014–6. Oct.
Colman, W. 1932. Effect of yeast on clothes moth larvae. JOUR. ECON. ENT. 25(6):1242. Dec.

Annual Insect Population Records, With Special Reference to the Kansas Summary*

ROGER C. SMITH, *Kansas Agricultural Experiment Station*

There is universal agreement that better control of injurious insects could be obtained if outbreaks or unusual numbers of injurious insects could be anticipated. It is also generally agreed that not enough information about the effects of variations of climate and other limiting factors, such as diseases, parasites and predators, is now available to undertake such predictions. Annual records of populations of insects correlated with weather, insect diseases, parasites, predators and crops are needed over a long series of years for each state and for neighboring areas. Evaluations of the effectiveness of the individual factors favoring or limiting populations must be made. These needs are well understood and generally admitted. This being the case, it appears that entomologists are slow in getting started making the necessary records and observations. Most of them are hesitant to begin making insect population summaries because almost every survey method yet suggested is more or less inaccurate or requires excessive time or funds to complete.

The purpose of this paper is to present a brief report on what is being done now in North America in so far as data were available and to discuss the various methods which are being used to gather information about insect populations.

POPULATION SURVEY SUMMARIES IN THE UNITED STATES AND CANADA.—Considerable information was obtained on this subject by means of a questionnaire sent to all states, Canada and Porto Rico in November, 1937. Here follows a summary of these reports:

Out of 42 returns from the states of the United States, Canada and Porto Rico, 17 reported that no sort of summary was prepared; 24 prepared a summary of one or more insects, of which 5 dealt with one insect, 9 with a few and 9 with many insects. Seven declared their summaries to be of an informal nature.

Five of the summaries have been carried on from 1 to 5 years, 5 from 6 to 10 years, 2 from 11 to 15 years, 3 from 16 to 20, 4 from 21 to 36 years. Connecticut with her splendid annual reports has the record of 36 years. Nebraska has kept a file record of notes and observations on the population of major insect pests for 31 years, Missouri for 27 years, while Kansas has such records going back for some insects about 60 years.

A summary of one or more insects is printed in 15 states, typed in 1 and kept primarily in the form of notes in 9 states. The summaries are published in 4 states in some scientific journal, in the state entomologist's report in 4 states, in a state academy of science report in 3 states, in the state horticultural report in 2 states, as part of some station or college report in 2 states. Ohio uses the bimonthly report for the purpose; Louisiana, the Sugar Bulletin; Texas, the weekly news releases; and Maryland the annual Report to the Board of Regents.

The data for the summaries of all sizes and scopes come in 17 cases primarily from general observations, field trips and surveys of the writers; in 7 cases, departmental correspondence is the source; in 5, use is made of entomologists or trained inspectors in their states.

Seventeen states reported that information about insect populations in summaries or notes is expressed descriptively

* Contribution No. 455 from the Department of Entomology, Kansas Agricultural Experiment Station. This paper embodies observations made on Project No. 6 of the Kansas Agricultural Experiment Station.

or by notes on abundance of the species, and 18 make use of damage done. Eight make use of arithmetical units and 4 use percentages. Nineteen reported that the recorded information is comparable either because of concepts used, of unity of method or of use of the same observer from year to year; 3 said the data are not comparable from year to year; 4 expressed doubt whether they are comparable.

Thirteen reporting officials stated that an especial effort is made to record and correlate weather, disease, parasites, predators and crop phenomena to insect populations; 5 said this is done "as far as possible" or "partly"; 7 said this is not being done.

Thirty-eight state officials reporting send information to the United States (or Canadian) Insect Pest Survey. One reported information is sent only incidentally, 1 stated it is sent for one insect only, and the Utah official stated the Pest Survey has now largely replaced the state summary. Only outbreaks are reported from Porto Rico now. The information reported to the Pest Survey is obtained in most cases by the same methods as are used for the state population survey. Twenty-two officials stated that general observations by the staff in connection with their regular work or research furnishes most of the information reported; 16 mentioned that the departmental correspondence is used; 9 mentioned county agents, 5 extension employees, 5 the extension entomologist, 9 trained entomologists or inspectors, 3 included farmers, 2 vocational agricultural teachers and 4 special field trips.

Twenty-seven reported that they keep a file of inquiries, usually a card index file, about insects from correspondents; one stating the file had been kept up for 40 years; 9 do not keep such a file; and 2 departments have discontinued it recently.

Eleven persons returned the questionnaire with printed or mimeographed reports dealing with insect population summaries of the types prepared in their states; 29 did not.

The Bureau of Entomology and Plant Quarantine has published in mimeographed form the Insect Pest Survey for 17 years and numerous annual summaries on the European Corn Borer, Japanese beetle and the other major pests. The Entomological Branch of the Department of Agriculture of Canada has for 15 years published in mimeograph form "The Canadian Insect Pest Review" (Twinn 1927). Annual insect population summaries have been a feature of the annual Reports of the Entomological Society of Ontario since 1870. The "trends" of the insects in each of the provinces brought out by listing them under "increase," "no change from the previous year" and "decrease" is a valuable feature of recent annual summaries in Canada.

Predictions of outbreaks or insect hazards for the coming year are features of the "Agriculture Outlook for Illinois" published in December of each year. The publication is a bulletin of the Agricultural Experiment Station and Extension Service in cooperation with the Illinois State National History Survey.

CHARACTER OF THE SUMMARIES.—A consideration of the replies shows that in general insect population summaries are based on correspondence and incidental observations made on trips or in connection with other projects. Data are obtained and recorded descriptively, except in the case of a few pests such as hessian fly, which lend themselves to a count of tillers or plants free and infested as are recorded in Ohio and Illinois published summaries. The splendid annual reports of the State Entomologist of Connecticut record not only most of the data of an annual summary but also results of research projects. The summaries of J. J. Davis, published annually in the Indiana Academy of Science, 1926–1936, are nearest of any seen to the type being prepared in Kansas.

In most cases, data on insect populations are published only in part and in several types of periodicals or reports. Publication of summaries is done chiefly in cases of outbreaks or more than ordinary damage. In most states, the larger amount of information on the subject is kept in note files and, if summarized, is made available only when papers are written on a certain insect for that state.

Practically all governmental units reported sending information to the Canadian or the United States bureau of entomology insect pest surveys. These excellent annual mimeographed records have become the chief sources of informa-

tion to investigators on yearly populations of Anthropods in North America. The federal grasshopper surveys have stimulated the gathering of information on these insects in the Central West. In general, the states are not doing very much toward making a comparable annual record of insect abundance, which includes records of both scarcity or absence of the forms, climatic effects, populations of enemies and other controlling factors in sufficient detail and extent to make long time studies on the subject possible. Such a record was begun seven years ago in Kansas. It is expected that the methods and results will grow steadily better as new ideas are introduced and the weak points corrected. At least, it is believed the survey is capable of being made somewhat superior to any method now followed anywhere. A discussion of the method with the advantages and weak points follows.

THE KANSAS SURVEY.—Since only incomplete bits of information on insect populations in Kansas had been recorded, particularly up to the time of the Insect Pest Survey, a plan for collecting and recording annually all the information which was available or could be obtained was undertaken in 1930. The plan includes use of all the competent sources of information in the state and the cost, exclusive of the wages of an NYA helper, is under $100 a year. The sources of the information obtained may be classified as follows:

1. The use of a questionnaire of the score card type and readily filled out is sent to four groups of persons in the state on or about July 1 and October 1 of each year. Replies total from 200 to 350 each year.

a. Entomologists (federal and state) or persons who have had professional entomological training or experience—18 in the state.

b. County agricultural agents in the state, most of whom have had at least one course in entomology—99 in the state.

c. Selected vocational agriculture teachers—about 75 selected.

d. College graduates now actually engaged in farming in the state. Only those who have had one or more courses in entomology receive questionnaires—about 75 selected.

2. Survey trips and random observations made by the

a. Extension entomologist, Dr. E. G. Kelly. All of his reports and special surveys are made available.

b. Writer and his departmental associates in travel over the state and in connection with agricultural experiment station projects.

3. Departmental correspondence.

Carbon copies of all material sent to the Insect Pest Survey are made available for the preparation of the annual summary.

Information is recorded by reporters by means of a scoring method. The directions as taken from a questionnaire follow:

> *DIRECTIONS: Score by number, 0 to 5 according to the following key,* your estimate of damage or abundance of the species listed below either from (a) personal observation or (b) reliable reports, in one or more counties. Score as many insects as you can in the list in the small squares below. Do this for all counties of Kansas for which you have information.
> Score 0, 1, 2, 3, 4, 5 according to the following key:
>
> *KEY:* Place 0—in the square when you have not seen the particular kind of insect listed at the left below nor have you had any reports of its presence in the county.
> Place 1—A few individual insects actually seen, or the species has been reported scarce.
> Place 2—Plentiful but not doing noticeable or reported damage.
> Place 3—The species is abundant; some damage has been seen or reported.
> Place 4—Local outbreaks; the species is doing severe damage in certain fields.
> Place 5—The species is in general outbreak. This rating is given only when the insects are doing their most severe damage or are as plentiful as they have been for many years in the various counties.
>
> *EXAMPLE:* 3a means that you have observed personally that the particular insect is plentiful and that it is doing some damage in your county. Ob may mean that the hessian fly, for example is, so far as reports indicate, absent in the county.

This key is followed by a vertical alphabetical list of around 40 insects listed by common names. Space is provided for the host or other notes and for scorings for four counties. A mimeographed guide of four pages illustrating one or more stages and in many cases the injuries of the various insects is sent with the questionnaires

to make certain the cooperator has the insects in mind under each heading.

Most persons do not give information on all the insects listed. Some give it for only one or two. Some include several counties in their reports, but most report for only their own county.

The state has been divided into 12 crop areas by the Agronomy Department with several subdivisions in two of them. In general, the population of the various species of insects is known to be fairly uniform in each of the crop and soil areas or their subdivisions. This is an assistance in interpreting the reports. A summary map is made for each insect, the scorings being recorded in each county with the last name of the scorer for checking back. Different colors of ink are used for each group of reporters. An average score number is computed for each county. Generally it is the arithmetical average omitting fractions and using the integer which agrees most closely with the scoring of entomologists, especially the extension entomologist. Likewise, the summary numbers in the other counties in the same crop area are used in eliminating fractions.

The published annual summary then includes the population score for each insect in as many counties as data are available, together with descriptive notes from observations. A weather and crop summary for the year is provided. Any known influences of weather, influence of disease, parasites, predators and similar information are also recorded in the summary. The whole is a summary of all information available and obtainable in the state on the subjects for the year. Six summaries have now been prepared and published in this manner (Smith 1932, 1934; Smith & Kelly 1933, 1935, 1936, 1937) and a seventh is in preparation.

ADVANTAGES OF THE KANSAS SURVEY.—Following are the advantages and good features of the Kansas type of insect population summary:

1. It is not expensive either as to time or money. The observations are recorded during the year in connection with other work, and the annual summary prepared during the late fall and winter.

2. It provides a written record summary each year of all the facts known at the time of writing about the state's insects included in the summary.

3. The reports are comparable year by year, and the data are adapted to making studies of relationships by years and counties to weather data. Cycles, trends or special influences of factors for predicting future populations may thus become apparent.

4. A start has been made, and some improvements, chiefly in the methods of gathering data or presenting them, are made year year in the expectation that a basically objective summary with uniform arithmetical ratings may be used by all reporters and that these same concepts may be found to be useful by other states.

DISADVANTAGES OF THE KANSAS SURVEY.—Following are the disadvantages of the Kansas insect survey:

1. It is yet largely subjective. While some reports are based on counts and sweeps, most are opinions based on observations, reports and personal experiences. However, a considered opinion of a well informed person is better than a great mass of undigested data. So far the score numbers do not mean a definite number of forms per square yard or other measure. While such units of measure are open to criticism, some definite scoring with indicated arithmetical ranges are now being considered.

2. Some reporters may not have the correct insect in mind when they report. The illustrated guide sent with the questionnaires is intended to aid in correcting this point.

3. Some persons underestimate; others overestimate in scorings. It is hoped that these differences are largely neutralized by the large number of questionnaires summarized.

EVALUATION OF THE KANSAS SURVEY.—All of these points and others are considered in interpreting the reports. Any scorings obviously incorrect are discarded. The local incorrect names of insects, such as armyworm for army cutworm, are known to the writer and their correct names are recorded. The same reporters are used each year and the annual reports are sent to most of the collaborators. There is a remarkable agreement in the score numbers reported and likewise agreement with counts as shown by the hessian fly survey and scorings in the 1933 report. An illustrated handbook of the insects of the state has been planned with an arithmetical range for each score

number for important insects. The use of score numbers is sound. This method, with five categories, also, and of similar concept value, is used in the federal grasshopper survey (Shotwell 1938).

It is hoped that all states may soon adopt some sort of uniform survey method and begin a comparable national insect survey by counties or crop areas. No method, not even quadrat nor sweeping counts will be entirely free from error or objections. However, a record of the information available from existing sources in the best form possible should prove of considerable usefulness both to present and future workers.—3-19-38.

LITERATURE CITED

Shotwell, Robert L. 1938. Some problems of the annual grasshopper survey. JOUR. ECON. ENT. **31**(4): 523–33. Aug.
Smith, Roger C. 1932. The Kansas survey for 1931. Jour. Kan. Ent. Soc. **5**(3):65–91. 1 pl.
Smith, Roger C. 1934. The Kansas survey for 1933. Jour. Kan. Ent. Soc. **7**(2):37–51.
Smith, Roger C., and E. G. Kelly. 1933. The Kansas survey for 1932. Jour. Kan. Ent. Soc. **6**(2):37–59. 1 pl.
Smith, Roger C., and E. G. Kelly. 1935. The Kansas survey for 1934. Trans. Kan. Acad. Sci. **38**: 171–85.
Smith, Roger C., and E. G. Kelly. 1936. The Kansas survey for 1935. Trans. Kan. Acad. Sci. **39**: 129–49.
Smith, Roger C., and E. G. Kelly. 1937. The Kansas survey for 1936. Jour. Kan. Ent. Soc. **10**(4): 113–32.
Twinn, C. R. 1927. The Canadian insect pest survey. Fifty-eighth annual report, Ent. Soc. Ontario: 67–9.

Studies on the Resistance of Apple to the Woolly Apple Aphid, *Eriosoma lanigerum* (Hausm.)

G. W. UNDERHILL and JAMES A. COX, *Virginia Agricultural Experiment Station, Blacksburg*

The woolly apple aphid, *Eriosoma lanigerum* (Hausm.), has been for many years a very injurious pest of apple trees in the nursery and of young trees in the orchard.

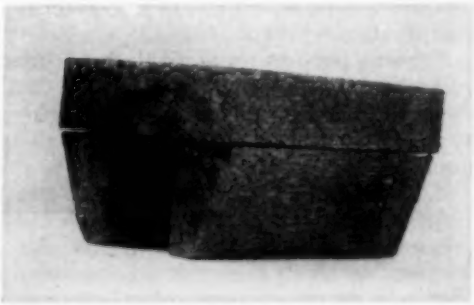

FIG. 1.—Wooden block used in making the pocket for the introduction of aphids.

It attacks all parts of the tree, and the roots of young trees in heavily infested areas are sometimes so severely galled that the trees die. The woolly aphid on the roots of apple is difficult to control by insecticides, and the use of root stocks that are highly resistant or are completely immune to the insect would be very desirable. In 1935 tests were begun to de-

FIG. 2.—Pocket about an apple root for the introduction of aphids.

termine the resistance of the roots of certain varieties of apple to the woolly aphid. This paper gives a report of the experiments conducted during the first three years.

METHODS.—Before the resistance studies were begun, a number of trees of certain varieties of apple had been induced to develop roots above the graft union. This was accomplished by girdling the scions of one-year-old grafts just above the union with pieces of copper wire. The girdling of the scion tended to stimulate root development above the point of girdling, and consequently the scion was established on its own roots. Only trees established and growing on their own roots were used in the experiments.

For infesting the roots with aphids the following technique was used: In outdoor experiments the roots were exposed by carefully removing the soil from one side of the tree. After a suitable root was selected, a rectangular block of wood (2 by 3 by 5 inches) with a deep groove along the center of one side, fig. 1, was placed over the root so that the groove formed a pocket around a portion of the root, fig. 2.

Apple twigs heavily infested with aphids were placed on the roots in the pocket. Then the pocket was covered with a wooden board and the soil replaced about the tree, thus simulating natural conditions. Root infestations were started in the spring as soon as aphids were available outside, and new infestations were started about every four weeks thereafter throughout the summer. Each series of root infestations was examined about four weeks after it had been made.

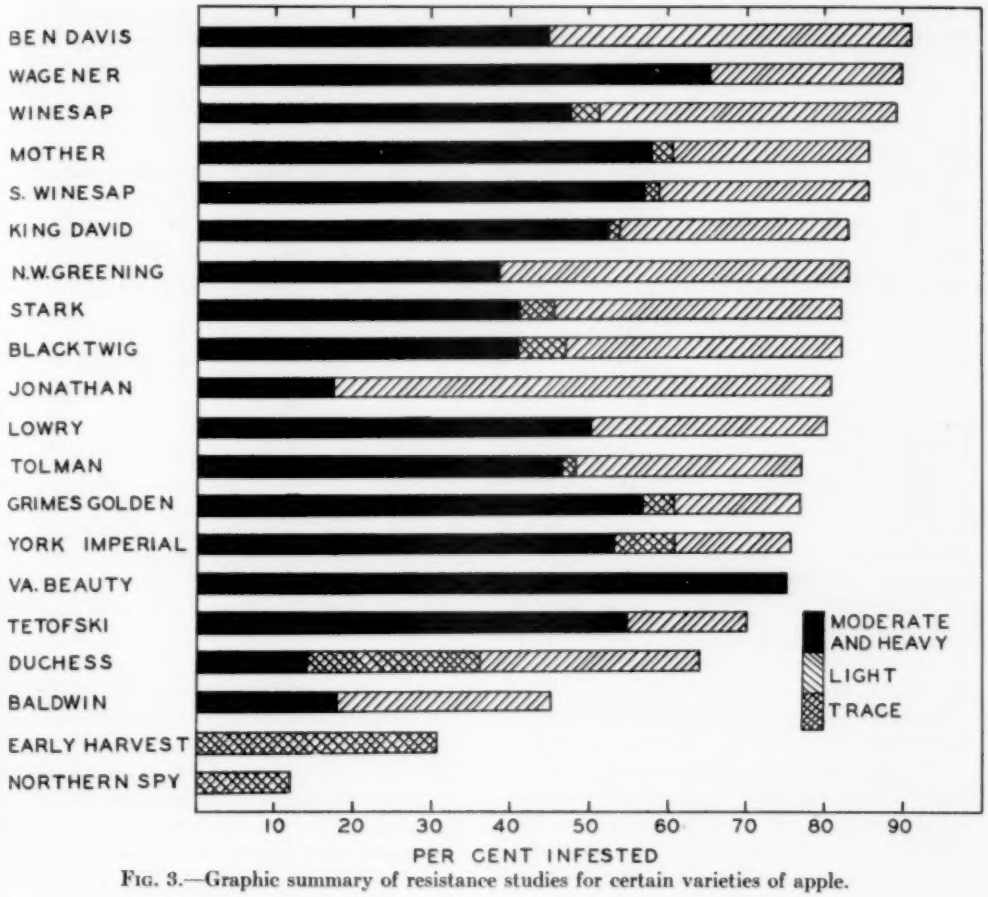

FIG. 3.—Graphic summary of resistance studies for certain varieties of apple.

FIELD EXPERIMENTS.—Twenty varieties of apple have been tested for their resistance to the woolly apple aphid. When the roots were examined an at-

tempt was made to classify the infestation of aphids according to the development of the colonies. The classification used is as follows: (1) trace, a temporary infestation of aphids on the roots, in which no galls formed and the aphids did not reproduce; (2) light infestation, small colonies developed and galls formed on the roots; (3) moderate infestation, medium-sized colonies developed and galls formed on the roots; and (4) heavy infestation, large colonies developed and galls formed on the roots.

In this paper the term "resistant" refers to any variety on which the aphids established temporary infestations but did not reproduce and did not stimulate the formation of galls. The term "susceptible" refers to varieties on which the aphids established permanent infestations and stimulated the formation of galls.

The results of the experiments for the three years are summarized in table 1, and a graphic summary of each variety tested is shown in fig. 3. Attempts to establish permanent infestations on the roots of Northern Spy gave negative results. Aphids were introduced on the roots of 78 trees of this variety and established temporary colonies on the roots of 10 trees, but failed to become established on the other 68 trees. The aphids did not reproduce and did not stimulate the formation of galls on the roots. The resistance of Northern Spy has been known for a long time. Becker in (1918), while making artificial infestations, was able to establish a few temporary colonies of aphids on Northern Spy roots; but he did not succeed in getting permanent colonies established. Le Pelley (1927) showed that the aphids could feed for a short time on Northern Spy, but they did not reproduce and did not stimulate the formation of galls. For all practical purposes Northern Spy may be considered a highly resistant variety. In the experiments Northern Spy was used as a check, and it was particularly useful in arriving at a conclusion about the other varieties.

As is shown in table 1 and fig. 3, Early Harvest is a highly resistant variety. Aphids were introduced on the roots of 32 trees of this variety, and they established temporary infestations on 10 trees, but did not become established on the other 22 trees. The aphids did not reproduce, and no trace of galls was found on the roots.

With the exception of Northern Spy and Early Harvest, no high degree of resistance was found in any of the varieties

Table 1.—Summary of resistance studies of apple to the woolly aphid.

Variety	Number of Trees Tested	Number of Trees Infested				Per Cent Infested
		Tr.[1]	L.[2]	M.[3]	H.[4]	
Ben Davis	45	0	21	13	7	91
Wagener	31	0	8	9	11	90
Winesap	27	1	10	5	8	89
Mother	67	2	17	23	16	87
Stayman Winesap	96	2	26	32	23	86
King David	42	1	12	11	11	83
Northwestern Greening	23	0	10	3	6	83
Stark	55	3	19	16	7	82
Blacktwig	34	2	12	6	8	82
Jonathan	16	0	10	1	2	81
Lowry	10	0	3	5	0	80
Tolman	43	1	13	10	9	77
Grimes Golden	79	3	13	24	21	77
York Imperial	34	3	5	10	8	76
Virginia Beauty	4	0	0	2	1	75
Tetofski	37	0	6	12	8	70
Duchess of Oldenburg	22	5	6	1	2	64
Baldwin	11	0	3	2	0	45
Early Harvest	32	10	0	0	0	31
Northern Spy	78	10	0	0	0	13

[1] Trace of aphids on roots.
[2] Light infestation of aphids on roots.
[3] Medium infestation of aphids on roots.
[4] Heavy infestation of aphids on roots.

tested. Most of the aphids established permanent colonies and stimulated the formation of galls on the roots of the following varieties: Ben Davis, Wagener, Winesap, Mother, Stayman Winesap, King David, Northwestern Greening, Stark, Blacktwig, Lowry, Jonathan, Tolman, Grimes Golden, York Imperial, Virginia Beauty, Tetofski, Duchess of Oldenburg and Baldwin. For all practical purposes these varieties may be considered susceptible to the woolly apple aphid.

SUMMARY.—Methods used for the artificial infestation of the roots of apple trees are described. A classification of the infestation of aphids is given and the terms "resistant" and "susceptible" are defined. The results of the experiments show that the varieties Northern Spy and Early Harvest are highly resistant to the woolly apple aphid, and the varieties Ben Davis, Wagener, Winesap, Mother, Stayman Winesap, King David, Northwestern Greening, Stark, Blacktwig, Jonathan, Lowry, Tolman, Grimes Golden, York Imperial, Virginia Beauty, Tetofski, Duchess of Oldenburg and Baldwin are susceptible to the woolly apple aphid.—3-21-38.

LITERATURE CITED

Becker, G. G. 1918. Notes on the woolly aphis. JOUR. ECON. ENT. **11**: 245–55. Illus.

Le Pelley, R. H. 1927. Studies on the resistance of apple to the woolly aphis. Jour. Pom. and Hort. Sci. **6**: 209–41. Illus.

The Control of Common Red Spider and Thrips by the Use of N,N Amyl Benzyl Cyclohexylamine*

C. W. KEARNS and C. C. COMPTON,† *Illinois Natural History Survey, Urbana*

In July of 1935 the senior author began a systematic study of the insecticidal properties of various N and N,N substituted derivatives of cyclohexylamine. The research funds used for this investigation were granted to the Illinois Natural History Survey and the University of Illinois by the Monsanto Chemical Company of St. Louis, Mo. The course of this exploratory survey extended over a period of two years during which time 79 derivatives of cyclohexylamine and many other derivatives of homologous compounds were tested as insecticides. Two compounds, namely N,N-amyl acetyl cyclohexylamine and N,N amyl benzoyl cyclohexylamine, were found to possess good insecticidal properties as related by Kearns & Flint (1937). These two compounds, however, were found to be rather phytotoxic. After considerable experimental work, it was determined that the acyl group was contributing to the phytocidal action of the compounds more than any other single factor. This point was definitely demonstrated when it was found that N,N amyl benzyl cyclohexylamine was more active insecticidally and approximately one-third as active in phytotoxic properties as its corresponding acyl derivative, N,N amyl benzoyl cyclohexylamine.

PHYSICAL AND CHEMICAL PROPERTIES.—The physical and chemical properties of N,N amyl benzyl cyclohexylamine are as follows:

Boiling point: 291.8 to 329.5 degrees C. at 760 mm. pressure

Liquid at least as low as −29 degrees C.

Specific gravity: 0.9261 to 0.9283 at 25 degrees/25 degrees C.

Refractive index: 1.5060 to 1.5076 at 25 degrees C.

Solubilities at 30 degrees C. (weight basis):

Methanol, 12 per cent
Ethanol (95 per cent), 16 per cent
Ethanol (absolute) and higher alcohols—miscible
Ethylene glycol, glycerol etc. <1 per cent
Ketones—miscible
Ethers—miscible
Aromatic H−C's—miscible
Petroleum Fractions—miscible
Vegetable Oils—miscible
Chlorinated Hydrocarbons—miscible
Esters—miscible

* This work was done under the direct supervision of Prof. W. P. Flint, Chief Entomologist, Illinois Natural History Survey and the Illinois Agricultural Experiment Station, Urbana.

† Early publication of this paper has been secured by payment of the printing charge.

Methyl cellosolve, 34.5 per cent
Higher cellosolves—miscible
Methyl carbitol, 6.0 per cent
Butyl carbitol—miscible
Water <0.0003 per cent
Flash point: 150 degrees C.
Fire point: 180 degrees C.
Discolors in iron, not in tin and zinc
Weak base—forms salts with HCl, H_2SO_4, fatty acids, etc.

FORMULATION STUDIES.—Since N,N amyl benzyl cyclohexylamine is a water insoluble liquid, the problem of preparing it in a form suitable for practical application led to a detailed study of the applicability of many commercially available emulsifying agents. Various soaps and sulfonated oils were investigated for this purpose. The type of emulsifying agent employed and its ratio to the amount of N,N amyl benzyl cyclohexylamine in the solution were found to be capable of producing great variations in toxicity due, presumably, to variations in the physical properties of the emulsions. None of the commercially available sulfonated oils or soaps which were tested could be said to be satisfactory in comparison with a material known as *Santobane A Emulsifier* which is at present being produced by the Monsanto Chemical Company for specific use as an emulsifying agent for N,N amyl benzyl cyclohexylamine.

In a previous publication Compton & Kearns (1937)‡ showed in laboratory tests that a concentration of .233 per cent N,N amyl benzyl cyclohexylamine (then known as C.P.100) was required to produce a 98 per cent mortality of the mobile stages of the common red spider, *Tetranychus telarius* (L.), on greenhouse roses, when the toxicant was applied in a formulation consisting of 70 per cent N,N amyl benzyl cyclohexylamine and 30 per cent by volume of a commercially available emulsifying agent known as *Albasol*. The results given in the following report are based entirely upon a formulation consisting of 70 per cent N,N amyl benzyl cyclohexylamine and 30 per cent of *Santobane A Emulsifier* by volume. Using this formulation it was found that only 0.116 per cent N,N amyl benzyl cyclohexylamine was required to produce results comparable to those obtained with .233 per cent N,N amyl benzyl cyclohexylamine as used in the *Albasol* formulation stated above. In other words, the toxicity of N,N amyl benzyl cyclohexylamine was approximately doubled by changes made in its formulation. A further advantage of the latter formulation over the previously published formulation of 70 per cent N,N amyl benzyl cyclohexylamine and 30 per cent *Albasol* is that it has sufficient wetting properties of its own to be effective without the addition of a wetting agent when used at dilutions of 1–600 or less.

‡ N,N amyl benzyl cyclohexylamine was called *C.P.100* in this publication.

METHODS.—The laboratory results recorded in this paper were obtained by treating the common red spider, *Tetranychus telarius* (L.), infesting Talisman variety of rose, and the onion thrips, *Thrips tabaci* Lind., infesting Turner variety of chrysanthemum.

It was necessary during the course of the investigation to test several hundred different formulations of N,N amyl benzyl cyclohexylamine. To accomplish this task by use of the generally accepted method of spraying infested potted plants would have entailed considerable expense in growing and maintaining large quantities of suitable material. In order to avoid this situation and at the same time obtain comparable results, the writers devised a method of keeping excised leaves in an apparently normal, turgid condition for a period of 48 hours, which times was sufficient to gather toxicological data upon the pests infesting the excised leaves.

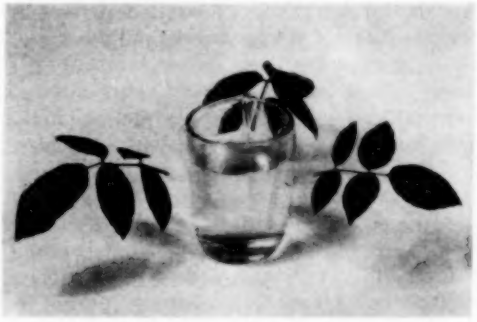

FIG. 1.—Watering system used in the experiment for keeping excised leaves turgid.

The problem of keeping excised leaves fresh for the desired period of 48 hours was accomplished by the use of the method illustrated in fig. 1. The bent glass tubing shown in the figure was 6 inches long and had an inside diameter of 4 millimeters. The tubing was hung, in

the manner shown, over the edge of a drinking glass which was partially filled with water. Then by slight suction applied to the end of the bent arm of the tubing, which extended at a 45 degree angle from the side of the drinking glass, water was brought from the drinking glass into the bent arm of the tubing. The level of the water in the drinking glass was then adjusted so that the column of water in the glass tubing would extend just to the tip of the bent arm. Then, after a spray treatment was applied to an infested leaf, the tip end of its stem was cut off sharply by means of a razor blade, and the stem was immediately inserted into the tip of the tube. A ring of petroleum jelly was then made around the stem at the point where it entered the tube, to keep water from running along the stem and on to the leaf. Leaves treated in this manner remained in approximately the same position and retained, from all superficial appearances, the same degree of turgidity as found when normally attached to the plant.

Laboratory tests on the mobile stages of red spider were accomplished by spraying infested leaves by means of an atomizer operated by a stream of compressed air under a pressure of 10 pounds per square inch. Leaves treated in this manner were placed in the above-described watering system, and the total number of normally mobile stages of dead and live red spiders was counted from 18 to 24 hours later.

In order to obtain data upon the toxicity of N,N, amyl benzyl cyclohexylamine to the egg and resting stages of red spider infesting rose, it was necessary to use young potted plants. Previous to treatment all the mobile stages of red spider were removed from the infested plants, and for 10 days following treatment each mobile individual that developed from an egg or resting stage was removed and recorded. This method did not take into consideration any difference in susceptibility which might be encountered because of variation in age or stage of development; so the results obtained can be considered only as indications of what might be expected under practical conditions.

Laboratory tests upon thrips were conducted in the manner previously described for the mobile stages of red spider, except that chrysanthemum leaves were used instead of rose. In mortality counts made upon thrips tests conducted in the laboratory, only those individuals which were between the stages of what appeared to be half-grown and adult were selected and considered in making mortality computations. The extreme susceptibility of the young stages to the spray solutions, and the heterogeneous type of population encountered made this procedure necessary in order to obtain a fair degree of homogeneity in results.

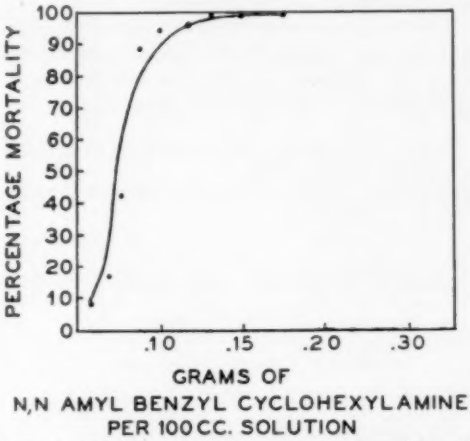

FIG. 2.—Toxicity of N,N amyl benzyl cyclohexylamine to the common red spider infesting roses.

In addition to the laboratory work conducted upon the toxicity of N,N amyl benzyl cyclohexylamine to thrips and red spiders, this compound has been extensively tested upon these pests in commercial greenhouses. In such instances the sprays were applied by means of power sprayers at pressures ranging from 250 to 350 pounds per square inch.

LABORATORY TESTS UPON RED SPIDER INFESTING ROSE.—The results of tests conducted in the laboratory upon the toxicity of N,N amyl benzyl cyclohexylamine to mobile stages of the red spider infesting roses are represented by the dosage-mortality curve in fig. 2. The toxicity of N,N amyl benzyl cyclohexylamine to the egg and resting stages of common red spider infesting roses was found by a limited series of laboratory tests recorded in table 1.

The data given in table 1 are not the product of a well-regulated experiment because the age and stage of development of the treated egg and resting stages were not definitely known. It became evident

during the progress of the experiment, especially in the case of the egg stage, that its degree of development at the time of the treatment was a factor contributing to its susceptibility or resistance. This was demonstrated by the fact that in cases where an incomplete kill of eggs was obtained, the majority of the unaffected individuals emerged either the day following application or five days later.

The results of experiments upon the egg and resting stages of red spiders infesting roses are included in this report because we believe them to be representative of the results which might be expected under practical conditions of application.

Table 1.—Toxicity of N,N amyl benzyl cyclohexylamine to the eggs and resting stages of common red spider infesting rose.

Concentrated N,N Amyl Benzyl Cyclohexylamine, Per Cent by Weight	Total Number Counted		Net Percentage Mortality	
	Egg Stage	Resting Stage	Egg Stage	Resting Stage
0.250	1912	Not determined	97	Not determined
0.200	872	591	91	98
0.170	1456	1128	79	99
0.140	654	802	54	89
0.116	407	96	32	81
Watersprayed check	351	262	2	4

Practical Application for Red Spider Control upon Greenhouse Roses.—Roses grown under greenhouse conditions are constantly affected by attacks from the common red spider. They are a crop which is extremely susceptible to injury by various spray materials, and for some unexplained reason harbor infestations of red spider which are more difficult to control than those found upon any other plant that has come to the attention of the writers. In view of the dire need for a suitable red spider control measure which could be applied to greenhouse roses, the greatest number of our laboratory tests and practical tests, conducted in commercial greenhouses, have been directed toward solving this problem.

At the present time the particular formulation of N,N amyl benzyl cyclohexylamine, previously stated in this paper, is being tested in various commercial greenhouses in the state of Illinois. The following varieties of roses have been treated under various conditions of culture and weather, without injury to any part of the plant and at the same time with satisfactory control of common red spider: Talisman, Mrs. F. D. Roosevelt, Joanna Hill, Hollywood, Better Times, Happy Days, Token, American Pride, Pernet, Ellen, Yellow Gloria, Signora, Wm. Ekas, Briarcliff, Carmelita and White Killarney. In most of our practical tests, the formulated material was applied at the rate of 1–400 without the use of a wetting agent. On the basis of laboratory tests, it was felt that a thorough application at this dilution should produce a mortality in mobile and resting stages of the red spider ranging from 96 to 100 per cent and at the same time produce a mortality of approximately 75 to 80 per cent of those in the egg stage. Our best efforts to determine the mortality percentage of various stages of the red spider in practical tests have resulted in corroboration of the results obtained in laboratory tests.

The results of laboratory tests made upon the toxicity of N,N amyl benzyl cyclohexylamine to red spiders infesting roses would indicate that it should be possible to control red spider effectively upon this crop by using the formulated material at the rate of 1–600. A number of tests conducted in commercial greenhouses have shown this to be possible, even though only a small percentage of eggs are killed when the material is used at dilutions greater than 1–400.

Efforts to make satisfactory recommendations for the frequency of spray application seem to be impossible in view of the many factors involved in the control of red spiders upon greenhouse roses. The results of practical tests which have been in progress over a period of time when red spider development is at its peak indicate that thorough applications made at the dilution of 1–400, on the basis of the formulated N,N amyl benzyl cyclohexylamine, are required about every 24 days

to keep a red spider infestation at such a low state as to cause no evident damage to the foliage or general plant vigor. Under almost the same conditions it would appear that an application at the rate of 1–600 would be necessary about every 18 days to produce comparable results. Recent tests conducted to determine the relative value of paired applications, which consisted of making the first application at the rate of 1–400, followed 5 days later by an application at the rate of 1–600, have resulted in a period of approximately 30 days of freedom from red spider in damaging numbers. These estimations are made upon the basis of tests conducted in one commercial greenhouse. Similar trials conducted in other localities and under different growing conditions have resulted in the need for both more and less frequent applications than those indicated above. Thoroughness of spraying and the degree of initial infestation should determine the frequency of application.

RED SPIDER CONTROL UPON MISCELLANEOUS CROPS.—The same formulation of N,N amyl benzyl cyclohexylamine which the writers have tested extensively under practical conditions for the control of red spider upon roses has been tested to a lesser extent upon other greenhouse and ornamental crops for the control of red spider. The results of these tests are shown in table 2. The plants listed in this table were not injured by the treatments applied. Of these crops, carnations and chrysanthemums received the greatest consideration; tests have been made upon practically all of the commonly grown varieties of each crop.

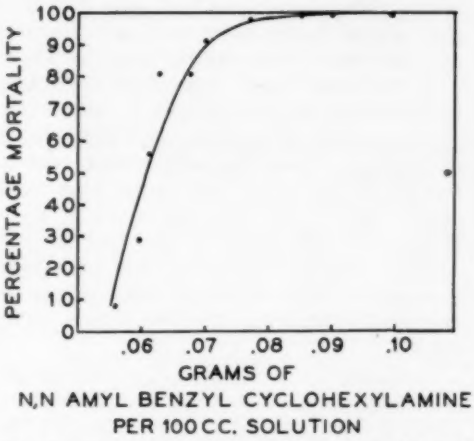

FIG. 3.—Toxicity of N,N amyl benzyl cyclohexylamine to *Thrips tabaci* infesting chrysanthemums.

Table 2.—Toxicity of N,N amyl benzyl cyclohexylamine to common red spider infesting various greenhouse crops.

PLANT	DILUTION OF FORMULATED N,N AMYL BENZYL CYCLOHEXYLAMINE*	CONCENTRATION N,N AMYL BENZYL CYCLOHEXYLAMINE, PER CENT BY VOLUME	PER CENT MORTALITY MOBILE STAGES
Chrysanthemum	1–1600	0.043	31
Chrysanthemum	1–1200	0.058	91
Chrysanthemum	1–1000	0.070	98
Carnation	1–1000	0.070	82
Carnation	1–800	0.087	96
Carnation	1–600	0.116	94
Lantana	1–1000	0.070	99
Lantana	1–800	0.087	99
Ageratum	1–1200	0.058	98
Ageratum	1–1000	0.070	96
Snapdragon	1–1000	0.070	93
Snapdragon	1–800	0.087	97
Verbena	1–1000	0.070	96
Cucumber	1–1600	0.043	99
Cucumber	1–2000	0.035	97

* An alkylated benzene sodium sulfonate was used as a wetting agent at the rate of 0.05 per cent by weight in all cases where dilutions greater than 1-600 (formulated material) were used in tests.

THRIPS TESTS.—The results of laboratory tests upon the toxicity of N,N amyl benzyl cyclohexylamine to *Thrips tabaci* infesting the leaves of chrysanthemums are shown by the dosage-mortality curve presented in fig. 3.

Opportunity for making a large number of practical tests upon thrips in commercial greenhouses have not yet become available on a large variety of crops. However, we have found it possible to obtain satisfactory control of both *T. tabaci* and *T. nigrophilus* Thr., infesting 23 varieties of young potted chrysanthemum plants, by applying two treatments one week apart, using the formulated N,N amyl benzyl cyclohexylamine at the rate of 1–1000 with 0.05 per cent of an alkylated benzene sodium sulfonate by weight added to the diluted spray to serve as a wetting agent.

SUMMARY.—A detailed study of the insecticidal properties of various derivatives of cyclohexylamine has resulted in the discovery of a compound, namely, N,N amyl benzyl cyclohexylamine, which is highly toxic to red spider and thrips.

The toxicity of N,N amyl benzyl cyclohexylamine, which is a water immiscible liquid, was found to be greatly influenced by the type of emulsifier and the ratio of emulsifier to toxicant employed in formulating it in a manner suitable for practical application. A formulation consisting of 70 per cent N,N amyl benzyl cyclohexylamine and 30 per cent of *Santobane A Emulsifier* has been found approximately to double the toxicity of the compound as previously reported by Compton & Kearns (1937) for red spider infesting roses.

The particular formulation of N,N amyl benzyl cyclohexylamine stated above has proved by laboratory and practical tests conducted in commercial greenhouses to be an effective means of controlling red spider and thrips on a variety of greenhouse and ornamental crops.—9-12-38.

LITERATURE CITED

Compton, C. C., and C. W. Kearns. 1937. Improved control of red spider on greenhouse crops with sulfur and cyclohexylamine derivatives. JOUR. ECON. ENT. 30(3):512–22. June.

Kearns, C. W., and W. P. Flint. 1937. Contact insecticidal properties of various derivatives of cyclohexylamine. JOUR. ECON. ENT. 30(1):158–66. Feb.

SCIENTIFIC NOTES

Physical Characteristics on the Foliage of Beans and Tomatoes That Tend to Control Some Small Insect Pests

During April, 1937, string beans at Phoenix, Ariz., became heavily infested with winged adults of the green peach aphid, *Myzus persicae* (Sulz.), which were migrating from the wild host plants that were drying. Breeding began immediately, but by the end of the first week in May it was observed that large numbers of the small nymphs as well as adults were dead, and that there had been a decrease from the original adult infestation rather than the expected increase. Between May 6 and June 30, 48 leaves were examined and 3,878 dead and 667 live specimens found. A close examination showed that these had become impaled on the recurved spines that may be found on the bean foliage, and that large numbers had died in attempting to free themselves. The larvae and adults of several species of thrips were also noted as becoming impaled, but not to the same extent as the aphids. The species of thrips involved were the flower thrips, *Frankliniella tritici* (Fitch), the onion thrips, *Thrips tabaci* Lind., *Scolothrips 6-maculatus* (Perg.), *Hercothrips* sp. and *Kurtomathrips morrilli* Moult.

The spines referred to are minute, strong and recurved at the tip in the manner of a fishhook. The points are sharp and readily penetrate the softer tissues of the insects when they come in contact with them. Small aphid nymphs and the larvae and adults of thrips may become fast or hooked in any part of the body or appendages, whereas the adult aphids more often become fast or hooked in the soft tissue of the leg joints.

Several factors may contribute in causing small insects to become impaled. The length of the spines in relation to the size of the insects is believed to be an important item which may cause certain insects to become impaled while performing their natural movements about the plants. The direct action of the wind may force some forms on to the spines, and the action of the wind on the plants, as when the stems and leaves become pressed together, may cause many to be caught. Quick, unnatural movements of the insects, as in attempting to escape parasites and predators, seem to increase their chances of becoming caught.

The effect that the semiarid climate may have in modifying the spines and causing them to become stronger and sharper than those on similar plants grown elsewhere is unknown, but it has been noted in other sections of the country that bean leaves become readily attached to clothing and that their removal produces a ripping or tearing effect as the spines are broken from the fibers of the cloth.

Tomatoes became infested with the green peach aphid during April when the winged aphids were migrating, and the flower thrips were also present in large numbers for a time, but early in May these forms had practically disappeared and the plants had suffered no apparent injury. A possible explanation for this disappearance may be the entanglement of the insects in a gumlike secretion or exudate from the tomato foliage.

This gum or exudate is formed on the tips of short, stocky spines and seems to consist of a four-celled or four-lobed mass of viscous fluid. This exudate readily adheres to the feet of the small insects as they move above the plants, and soon a collection sufficient to interfere with normal movements has accumulated. The claws on the feet may become so covered that the insects are unable to retain a hold on the plants when the exudate hardens, or they may be held on the plants if a sufficient quantity of the exudate of proper consistency has accumulated.

What influence the semiarid climate may have upon this exudate, or upon the plants in secreting the exudate, is unknown. Adaptations of the plants to overcome the excess evaporation may increase this secretion, or the secretion may be reduced to a consistency that allows it to adhere more tenaciously than it might in localities with different weather conditions.—1-7-38.

K. B. MCKINNEY, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*

Toxicity of Ether-Soluble and Ether-Insoluble Fractions of Commercial Phenothiazine to Certain Insects

The results of laboratory tests (Campbell *et al.* 1934; Smith, Siegler & Munger 1935) with phenothiazine justified a field test in 1934 in which this compound was used as an insecticide for the control of codling moth larvae. The results of this test were not promising (U. S. Department of Agriculture 1934).

Upon chemical examination of the compound used in 1934, it was found that when extracted with ether in a Soxhlet apparatus a fractionation was obtained (Smith 1938). The ether-soluble part was as toxic to the codling moth larva as pure phenothiazine and the ether-insoluble part was relatively nontoxic to the same insect (Siegler, Munger and Smith 1936). The two fractions were tested by D. E. Fink (private communication) against mosquito larvae. The ether-insoluble fraction at concentrations of from 0.005 to 0.1 per cent in water produced no kill. At all tested concentrations over this range the ether-soluble fraction gave 100 per cent kill, this being comparable with the results obtained when pure phenothiazine was used.—6-24-38.

L. E. SMITH, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*

LITERATURE CITED

Campbell, F. L., W. N. Sullivan, L. E. Smith and H. L. Haller, 1934. Insecticidal tests of synthetic organic compounds—chiefly tests of sulfur compounds against culicine mosquito larvae. JOUR. ECON. ENT. **27**(6): 1176–85. Dec.

Siegler, E. H., F. Munger and L. E. Smith. 1936. Laboratory tests of phenothiazine against codling moth larvae. JOUR. ECON. ENT. **29** (3): 532–37. June.

Smith, L. E. 1938. Analysis of commercial phenothiazine used as an insecticide. Indus. Eng. Chem., Anal. Ed. **10**: 60.

Smith, L. E., E. H. Siegler and F. Munger. 1935. Phenothiazine, a promising new insecticide. (Sci. Note) JOUR. ECON. ENT. **28**(4): 727–8. Aug.

U. S. Department of Agriculture, Bureau of Entomology. 1934. Results of codling moth investigations, 1934, pt. 2: 4–5, 13, mimeographed.

The Weight of Foliage from Different Crown Levels of Trees and Its Relation to Insect Control

The study of several hundred samples of leaves having a total area of more than 50,000 square inches, collected from different crown levels of several species of trees during the past few years, in connection with insecticide investigations, revealed that the leaves from the upper part of the crown are heavier per unit area than those from the lower part of the crown.

Leaves from the upper crown level of red oaks growing in dense stands weighed 43 ± 0.32 per cent more per unit area than those from the lower crown level. However, there was a difference of only 18 ± 0.12 per cent in the weight of the leaves from the two crown levels of red oaks growing in the open. Needles from the top of the crown of white pines growing in dense stands weighed 12 ± 0.15 per cent more per given length than those from the lower portion of the crown, whereas there was a difference of 33 ± 0.35 per cent on trees of this species growing in the open.

Generally, in New England at least, the leaves from the upper part of the crown of the deciduous trees examined were smaller in area than those from the lower part of the crown. On the other hand, the needles from the upper part of the crown of the conifers examined were longer than those from the lower part of the crown. There was very little difference in the weight per unit area of leaves from the same crown level of the various species of deciduous trees, but there were considerable differences among the coniferous species in this respect. The trees sampled include those of white, red, Norway and blue spruce; white, pitch and red pine; red cedar; larch; hemlock; red, white and scarlet oak; American elm; red and Norway maple; beech; white ash; shagbark hickory; gray and paper birch; and wild black cherry.

Since the effectiveness of a stomach-poison spray against insects that consume the whole or large parts of leaves depends upon the quantity of poison deposited per given weight of foliage, rather than per given area, the weight of the foliage is of primary importance in the application of sprays for insect control. In ground spraying there is usually a greater deposit of insecticide per unit of leaf area on the foliage in the lower part of the crown than on that in the upper part of the crown. This difference in deposit is even more pronounced on the basis of leaf weight. Actually, a greater deposit per unit area of foliage is needed in the upper part of the crown, because the leaves at that level are thicker and that portion of the tree needs the most protection from insect attack.

Observations on three leaf miners, *Lithocolletis* sp., *Fenusa pusilla* (Lep.) and *Phyllotoma nemorata* L., showed that these species, which live between the two surfaces of the leaf, are found more frequently in the thick "sun" leaves than in the thin "shade" leaves. The feeding mines or cells in the "sun" leaves are also larger than those in the "shade" leaves. Larvae of *Porthetria dispar* (L.) and *Ellopia athasaria* Walk. fed on foliage from the top of the crown attained a greater weight than those fed on foliage from the lower crown.—7-1-38.

S. F. POTTS, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*

Note on the Attempted Establishment of *Paratheresia* in Louisiana

Referring to H. A. Jaynes' article, "Introduction and Recovery in Florida and Louisiana of Parasites of the Sugarcane Borer," in the JOURNAL OF ECONOMIC ENTOMOLOGY, **31**: (1) 93–5, February, 1938, the present writer protests against the confusion of species there practiced. See the *Manual of Myiology*, **3**: 145, 148–50, and **4**:268 (1936) for data on the distinctness of *Paratheresia claripalpis* (V.d.W.) and *P. signifera* Towns., as well as *P. diatraeae* (Brèthes). The confusing of these species is responsible for the failure to establish *Paratheresia* in Louisiana.

Paratheresia signifera is an arid region species which can not readily adapt itself to humid conditions, while just the reverse is the case with *P. claripalpis*. If the latter species had been brought from Veracruz to Louisiana, it would quite certainly have become established. Is it not time to recognize these facts, now that they have been clearly pointed out? It is significant that, six to nine years after heavy importation and liberation of *P. signifera* in Louisiana, no establishment has been secured.

The *Paratheresia* found in 1936 at Jupiter, Fla., may be an endemic species. If so, it is strange that it has not been found either in Cuba or in Louisiana. It seems more likely to be the subhumid *P. diatraeae*, which may have been present in the Florida liberation. If endemic in Florida, it would be worth while to attempt its establishment in Louisiana.

The reference of these species to *Theresia* is questionable taxonomically and is equivalent to referring the tribe Theresiini to the one genus *Theresia*. Nor are these flies dexiids. They belong to the family Prosenidae. *Musca volvulus* F., a wholly different fly, was designated by Westwood (1840) as the genotype of *Dexia*, type of the family Dexiidae.

The *Manual of Myiology* treats in full the classification of these flies. Would it not be wise to adopt the nomenclature as there pointed out and avoid further confusion in the handling of distinct forms?—7-1-38.

CHARLES H. T. TOWNSEND, *Itaquaquecetuba, EFCB, São Paulo, Brazil.*

Microtechnique Method of Testing Oil Insecticides on Scale Insects

During a period of many years the writer was interested in experiments on the efficacy of oil in the control of scale insects. A disheartening feature of this work lay in the fact that the experimental error involved in orchard tests was so large that it seemed virtually impossible to establish the relative merits of different insecticides except within rather broad limits. The literature of economic entomology affords considerable evidence that this experience has been common to investigators who have been similarly engaged. The extensive literature on the control of the San José scale is replete with discordant data. With the view of securing data of greater reliability, peach seedlings were infested with San José scale, and sprays were applied with an atomizing device in the laboratory. This was in 1923–1924. From 1927 to 1930 extensive tests were made in which lemons infested with the California red scale were sprayed in a technical manner in the laboratory. In all of this work the range in error, as shown by replicated tests, was too great to permit the distinguishing of differences of 1 per cent or even 2 per cent in the absolute killing effectiveness of any two given sprays. Where an orchard is heavily infested, a treatment may be decidedly unsatisfactory if it permits a survival of 1 per cent.

Microscopic examinations revealed a wide range as regards the extent of penetration of oil into the tracheae of the insects receiving a given treatment. All the spiracles and adjoining tracheae of a particular insect would be filled, while only a small amount of oil would be present in but one spiracle or one tracheal branch of an insect situated almost contiguous to the first insect. To be sure, where the oil concentration in the spray was high, all the tracheae would be filled and all the insects would invariably be killed. The variable results were obtained where the concentration was reduced to the extent that a small survival resulted.

The microtechnique method herein described represents an attempt to find a way of testing scalecides with greater precision and dispatch than can be accomplished by orchard experiments or by the type of laboratory experiment referred to above. It involves simply the placing of the oil directly into the spiracle of the insect, or upon any desired part of the body, and determining the effect by observation under the microscope. The technique that has been employed in studies with armored scale insects is described as follows: Insects that are well along in the second instar of development and those in the early part of the third instar are selected. After the body becomes filled with eggs or embryos, it becomes relatively impervious to light and the tracheae cannot be seen with desired clearness. With the aid of a wide-field microscope and dissecting needles of suitable fineness, the armor is removed. The body is manipulated with care so as not to cause injury, and the stylets are pulled completely out of the host or they are pulled part way out and cut off. A very thin smear of tanglefoot, about 1 millimeter wide and 1 or 2 centimeters in length, is applied to a microscope slide. The insects are placed in order on the smear, with their dorsal surface in the tanglefoot, and are numbered consecutively.

The application of the oil is made under a compound microscope with the aid of a 16 millimeter objective. A fine spine of an *Opuntia* cactus, attached to the end of a dissecting needle, is used for applying the oil. The tip of the spine is dipped into the oil and placed on the spiracle or any particular part previously brought into sharp focus. Practice alone will enable one to apply the amount determined upon. Where the application is to be made to the spiracle, a sketch of the adjoined tracheae is first made because the tracheae become more or

less invisible when filled with oil. Following the application, the oil-filled tracheae or the extent of oil penetration is indicated on the sketch. Additional sketches are made at intervals of time to show the location of the oil or its movement as affected by the efforts of the insect to eject the oil. The numbering of the insects on the slide enables one to keep a record of each treatment and the reactions of each insect.

After the applications have been made to the several insects, the slide is placed in a Petri dish and the dish is kept in subdued light. A small wad of moist cotton is placed in the dish to increase the humidity. Under this condition untreated insects may be kept alive for several days. Insects manifest various reactions denoting the effects of treatments made. Usually no general body movement results where highly-refined oil is introduced into the spiracles. Oil that contains pyrethrum produces spasmic movements, often intense, in the region of the body to which the oil is applied. The progress of lethal effect may be judged by the intensity and the rate of movement of the salivary pump. With the approach of death, faint movement may be induced by reflecting light of high intensity upon the insect, using the mirror of the microscope.

The method has been employed with particular satisfaction in studies with highly-refined oils that have been fortified by the addition of pyrethrum, rotenone and other substances with the design of making the oils toxic. Its usefulness can probably be enlarged through the use of micromanipulating apparatus of the type employed in the field of biology.—8-12-38.

RALPH H. SMITH, *University of California, Los Angeles.*

The Effect of Cold Storage on the Reproduction of Parasitic Hymenoptera

In biological control work, low temperatures are used to facilitate the transportation of parasites over long distances and to regulate the timing of liberations. A number of successful introductions have been made of parasites that have been subjected to low temperatures but more often the effort has resulted in the failure of the parasite either to survive transportation or to continue reproduction. E. W. Rust, who was sent to South Africa by the University of California to collect black scale parasites, reported to Professor Harry S. Smith in 1926, that he had concluded that the cause of the failures of most of his shipments during the preceding seven years was due to the *prolonged* low temperatures during transit, rather than to too cold temperatures.

The low temperatures generally used in biological control work are above the threshold of metabolism of the parasite. The optimum storage temperatures are considered to be just below those which would permit development to continue to the following stage. Such temperatures, however, may insure the survival of the individual but not the survival of the species.

It is customary to place parasites in cold storage when they are mature larvae or pupae, for experience has shown that *emergence* of the adult is then least affected. Metabolic activity during the mature larval and pupal periods is dependent on nutritive material accumulated in the body during the immature larval stages. If storage is prolonged it is evident that the parasite may not have sufficient material with which to complete its development. The organs most likely to be affected by insufficient nutrition are those used in reproduction. The germ cells which undergo their greatest development during the pupal and adult stages appear to be adversely affected. The spermatozoa in particular seem to lack vitality.

In dissecting several adults of a species of *Tetrastichus*, some of which had been stored for two weeks as pupae, the writer observed that in the unrefrigerated specimens the fat cells were abundant, whereas in the refrigerated ones they were scarce.

Hanna (1935) observed that the adults of *Euchalcidia caryobori* Hanna produced progeny in the normal sex ratio when exposed as larvae to low temperatures, but if exposed as pupae they produced progeny consisting mostly, if not entirely, of males. Since *Euchalcidia* is arrhenotokous this indicated that the male pupae were more or less sterilized, at least temporarily. Hanna found that oogenesis was much less affected than spermatogenesis. This indicates a correlation with nutrition.

Uvarov (1931) states that the development of gonads may be seriously inhibited by temperature which can hardly be called low in the usual sense of the word. The experiments of Hanna constitute a remarkable example of such a phenomenon. He subjected male pupae to a constant temperature of about 60.8 degrees F. (16 degrees C.) for periods of 10, 25 and 40 days and found that the 10-day exposure resulted in 70 per cent sterile males, the 25-day exposure 90 per cent sterile males and the 40-day exposure 100 per cent sterile males. It should be noted that 60.8 degrees F. can be called low only with respect to *E. caryobori*, a tropical species. The breeding of parasites at temperatures not considered low may result in the progressive decline of the proportion of females in successive generations until the stock dies out completely.

The optimum temperature for the production of sperm in the parasitic Hymenoptera may be in the neighborhood of 86 degrees F. (30 degrees C.) as Anderson (1935) found to be the case of *Habrobracon juglandis* (Ash.).

Anderson (1935) and Van Steenburgh (1934) have shown that the fertility of parasites subjected to low temperatures during development may be adversely affected. Supposedly healthy mature parasites, therefore, may be in fact more or less impotent. The recognition of this possibility is of considerable importance in biological control work.

A statement by Schread & Garman (1933) to the effect that the progeny of refrigerated (38 degrees to 40 degrees F.) specimens of *Trichogramma* consisted mostly, if not entirely, of males first suggested to the writer the reason for the failure of many introduced parasites to reproduce, *i.e.*, sterility of the male as a result of cold storage during shipment.

In 1938 the writer under the direction of Professor Harry S. Smith, reared and released several thousand elm leaf beetle egg parasites (*Tetrastichus* sp.) introduced into California from Japan by the Bureau of Entomology and Plant Quarantine. The parasites, apparently in all stages of development, were 14 days en route at temperatures of about 38 degrees F. The host did not survive shipment, but there was little, if any, parasite mortality. Approximately 5000 adult parasites were reared from 1326 egg masses. Dissection of the reproductive organs of both sexes revealed a curious situation. The vesiculae seminales of the males were filled with spermatozoa, but the viability of the spermatozoa varied in different individuals, being very active in some and

sluggish or inactive in others. On the other hand, the spermatheca in each of the females appeared to be devoid of sperm, although the sexes had ample opportunity to mate. Courtship by the males occurred but mating was not observed. Reproduction, however, resulted in some female progeny so either mating did occur or the species is deuterotokous.

Possibly hymenopterous parasites should be held in storage as either immature larvae or as adults if their reproductive capacity is to be unimpaired. The exposure to low temperature during these stages probably would not be detrimental if interrupted at regular intervals for short periods of normal respiration and feeding.

Experiments are in progress to determine the effects of prolonged storage during the immature stages on the progeny of parasites.—8-26-38.

S. E. FLANDERS, *University of California Citrus Experiment Station, Riverside.*

LITERATURE CITED

Anderson, R. L. 1935. Offspring obtained from males reared at different temperatures in *Habrobracon*. Amer. Nat. **69**: 183–7.

Hanna, A. D. 1935. Fertility and toleration of low temperature in *Euchalcidia caryobori* Hanna (Hymenoptera, Chalcidinae). Bul. Ent Res. **26**: 315–22.

Schread, J. C., and Philip Garman. 1933. Studies on parasites of the oriental fruit moth. Conn. Ag. Exp. Sta. Bul. **353**: 691–756.

Uvarov, B. P. 1931. Insects and climate. Trans. Ent. Soc. London **79**: 1-247.

Van Steenburgh, W. E. 1934. *Trichogramma minutum* Riley as a parasite of the oriental fruit moth (*Laspeyresia molesta* Busck) in Ontario. Can. Jour. Res. **10**: 287–314.

JOURNAL OF ECONOMIC ENTOMOLOGY
Official Organ American Association of Economic Entomologists

Vol. 31 October 1938 No. 5

Entomologists Don't Rate

THE sixth edition of *American Men of Science* is off the press. It contains 28,000 names. The first edition, issued in 1906, contained about 4,000. The large increase in the number of entries is indicative of the expanding importance of American science during the past 32 years. Size and completeness of the sixth edition are indicative of the valuable service performed by this biographical directory in making scientific leaders acquainted with the work of one another.

Like all other works of human minds and hands, however, *American Men of Science* contains elements which are subject to differences of opinion.

One of the interesting features of this biographical directory, begun with the first edition, is the starring of subjects of research by scientists "who are judged by their colleagues to have attained a position among our thousand leading scientific men." The sixth edition, like the fifth, contains 250 new stars.

The making of such a selection has its limitations even under the most favorable circumstances. Anyone acquainted with the difficulties of a scientific society in dividing its own membership into various classifications based upon achievements recognizes the difficulties of the problem. In a volume which pretends to cover the entire field of science, the difficulties become proportionally greater.

Reference to *American Men of Science* a few days ago started a short, informal investigation of the way entomologists have fared in this publication.

This nation has a number of prominent entomologists—men whose researches have contributed richly to fundamental knowledge and to the welfare of the human race. The investigation revealed that the number of entomologists starred was insignificant and entirely out of proportion to the number of scientists in other fields starred by colleagues. Almost the only entomologists starred were those closely associated with zoological departments or those who have done work in orthodox zoology.

The findings of this informal investigation are accounted for in part by the preface to the first edition. As explained there, the 1,000 names receiving stars were divided among the sciences as follows: chemistry, 175; physics, 150; zoology, 150; botany, 100; geology, 100; anatomy, 25; anthropology, 20.

Recent editions have adopted the same proportional quota in starring new names. Entomologists as such are not considered.

When the first edition of *American Men of Science* was published, the editors undoubtedly thought of entomologists as belonging with the group of zoologists. No entomologist will deny that the basic classification of his work puts him in the zoological division. So, too, might anthropologists, physiologists, psychologists, anatomists, and pathologists be considered zoologists.

Since 1906, when the classification quotas were set up, the scientific and commercial importance of entomology has increased enormously. But the basis of awarding stars in *American Men of Science* has not changed.

Regardless of the fundamental relationship between entomologists and zoologists, between insects and other animals, entomology has become a science in its own right. Because of the diversity and complexity of the insect world and the tremendous economic importance of insects, entomologists now occupy a plane of their own. Entomology is too big a subject to lose in some other category.

The American Association of Economic Entomologists at its last annual meeting listed 1,118 members. After allowance for duplication of names is made, membership in this organization and the Entomological Society of America totals approximately 1,400. The American Society of Zoologists lists slightly more than 800 members.

Entomologists have no fight to pick

with their brethren the zoologists. They cannot forget, however, that under the present system the starring of their names in *American Men of Science* is controlled by zoologists.

Because zoologists are better acquainted with the work of other zoologists than they are with that of entomologists, when the stars are passed around the zoologists get the call. Now and then an entomologist slides in on the coat-tails of a zoological label because he is devoting all or part of his time to traditional zoological studies or is closely associated with other zoologists. But the entomologist as an entomologist is ignored.

The importance of entomology need not be defended at length in a magazine devoted to entomology. R. C. Roark in *Chemical Industries* estimates that the retail cost of insecticides and fungicides sold annually in the United States at probably not less than $100,000,000. He states that damage caused by insects in this country may be conservatively reckoned at about $2,000,000,000 annually.

The American people are not so gullible that they will assign work of such importance as that of battling a $2,000,000,000 enemy to an inferior branch of science or to men of inferior intelligence. Results of some entomological work can be measured more quickly and objectively than that of many other scientific fields. The economic entomologist must produce satisfactory measurable results or retire from the field.

The time has come when the American Association of Economic Entomologists through its officers or the Joint Committee on the Promotion of Official Entomology should recognize the present unequal representation in *American Men of Science* and start a movement for its correction.

A solution of this problem would be that, in future editions of *American Men of Science*, entomologists as a group be given a definite quota in the hall of stardom and that names for this quota be selected by entomologists rather than by zoologists unfamiliar with the vast amount of research in the field of entomology.

Science is a science, whether it is concerned with the heartbeats of a frog or the reaction of mosquitoes to rotenone; whether it is carried on in ivied halls or in marshy wastelands. Entomology is not less scientific than zoology because a great part of its efforts bear directly upon human welfare. Because of the number of entomologists and the importance of their problems, entomology deserves in *American Men of Science* recognition equal to that given other sciences—proportional representation.

For a number of years, entomologists witnessed, at meetings of the American Association for the Advancement of Science, accommodation assignments out of line with society membership roles and representative attendance. Aroused action by the American Association of Economic Entomologists has corrected this situation.

Perhaps further recognition of the entomological profession might result from the suggestion that the American Association for the Advancement of Science consider entomology as a separate section. Too often, in its relation to zoology, entomology finds itself in the position of the tail that wags the dog. The good and bad points of this suggestion are worth considering.

Meanwhile, entomologists just don't rate.

REVIEWS

Lac Cultivation in India, by P. M. Glover, Entomologist, Indian Lac Research Institute, 1937. 147 pp., 22 tables, 9 text figures 14 plates, 2 colored plates. Price Rs. 2/– Published by Dr. H. K. Sen, Director of the Institute, Namkum, Ranchi.

Although the lac scale, *Laccifer* (*Tachardia*) *lacca* Kerr, is the means of livelihood for thousands of Indian natives and has an annual commercial value reaching millions of dollars over the world, the methods of cultivation of this insect and the process of manufacturing the commercial articles derived from it are but vaguely familiar to most entomologists outside of India. This book, a revision of the author's "A Practical Manual of Lac Cultivation," 1931, is therefore welcomed for the complete picture it presents of this very valuable species of an otherwise exceedingly destructive family of Homoptera. Accordingly, it is a book which deserves to be found in all agricultural and entomological libraries.

However, it was prepared primarily to anticipate the numerous requests from growers in India for practical information regarding the cultivation of the lac scale. Much of this information was produced in years of investigation by the Indian Lac Research Institute. The 22 chapters treat such topics as the production of stick lac, the prices of unmanufactured stick lac for 1929 to 1937, methods and practice of lac cultivation, propagation, pruning and pruning instruments, inoculation of lac trees, forecast of the

swarming date, harvesting the crop and its subsequent treatment, manufacture of shellac, the use of different tree species as hosts, lac cultivation in the several provinces of India, insect and other enemies of lac and the insect enemies of the host trees. Supplementing these chapters are three appendices, of which the first two list the host trees mentioned in the text, with their technical and vernacular names, while the third presents a very helpful glossary of the many Indian names connected with lac production and the shellac industry. Another feature of value is the chronologically arranged bibliography of 59 items. The illustrations, which are largely photographs and drawings, are mostly fair to good in quality and well chosen to represent the important aspects of the cultivation of lac and the manufacture of shellac. The first colored plate presents the sexes and stages of *Laccifer lacca* and also lac on the stick. The second shows the stages of the two most important lepidopterous enemies of the lac scale, namely the noctuid *Eublemma amabilis* Moore and the blastobasid, *Holcocera pulverea* Meyer.—6-22-38.

W. V. BALDUF, *University of Illinois, Urbana.*

Studies on the Corn Borer (*Pyrausta nubilalis* Hbn.) in Connection with the Infestation of Hops (*Humulus lupulus* Lin.) and Millet (*Panicum miliaceum* Lin.), by E. Judenko. 1938. Biblioteka Polska 17: 19–122, 9 figs. Bydgoszcz (Bromberg), Poland.

The seasonal occurrence of the European corn borer in hops and millet in central Poland from 1931 to 1934 is given. The lengths of egg, larval and pupal stages under different temperatures are discussed. A map gives the distribution of the corn borer in Poland.

In the region of Pulawy, which is not situated in in the chief maize producing area, the corn borer was found to have but one generation a year. Maize plantations in this region were found infested by the larvae of *Pyrausta* only when the neighboring millet fields were infested and millet growing next to hop fields was more infested than when it grew at a distance from them.

The density of infestation of hops by *Pyrausta* varied from 58 to 76 per cent with an average of from 2.2 to 3.6 larvae per shoot during the time of ripening. Percentages of infestation up to 30 were found in the millet depending on the time of sowing. The difference between the weight of hops from infested and non-infested hop shoots was not considerable. On the other hand, the yield of cones from a field in the district of Pulawy was almost completely destroyed in 1933. In test plots of millet (red *erectum*), sown on April 25, the loss in weight of grain due to borer infestation amounted to 9.5 per cent in 1933 and to 3.3 per cent in 1934.

The seasonal occurrence of seven parasites is given, but with no data on percentage of parasitism.

Control measures are recommended by the author in regions where only millet, where only hops, and where both crops are grown.—9-7-38.

L. H. PATCH, *European Corn Borer Laboratory, Toledo, Ohio.*

OBITUARY

Roy A. Vickery 1883-1938

Roy Albion Vickery, 54, Associate Entomologist, Bureau of Entomology and Plant Quarantine, died at San Antonio, Tex., July 13, 1938. He had not been in good health for several months previous to his death.

He was a native of Minnesota, and received his bachelor's and master of arts degrees from the University of Minnesota. For about 30 years he had been in government service, having been stationed at Boston, New York, Brooklyn, Washington, D. C., Brownsville and San Antonio, Tex. At the time of his death he was serving with the Division of Pink Bollworm Control.

His activities included work with cereal and forage insects, army worm parasites, wingless May beetles and the Aphididae.

Mr. Vickery was a member of the American Association of Economic Entomologists, Entomological Society of Ontario, Imperial Institute of Entomology, Ecological Society of America, American Amaryllis Society, Texas Entomological Society and the Texas Academy of Science. He was a member of the Sigma Xi Fraternity and the Elks lodge. He is survived by a sister, three nephews and a neice, all of San Antonio. Funeral services were held at San Antonio on July 16.—8-5-38.

OLIVER I. SNAPP, *U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.*

Roy A. Vickery

CURRENT NOTES

Meeting of Tobacco Insect Council

The second annual meeting of the Tobacco Insect Council was held in Oxford, N. C., July 19, 20 and 21. The agronomists and plant pathologists interested in tobacco problems met at the same time. On July 19 a joint session was held with these groups of workers during which W. H. White delivered an invitation paper entitled, "Some Research Problems on Tobacco Insects."

This conference was attended by the following entomologists: W. D. Reed, Chairman, S. Marcovitch, Secretary, Z. P. Metcalf, W. J. Schoene, E. N. Cory, J. O. Rowell, C. B. Dominick, W. A. Shands, B. B. Fulton, A. W. Morrill, Jr., Norman Allen, H. C. Hallock, W. W. Stanley, Clemence Levin, W. H. White, C. Graham and F. S. Chamberlin.

Visitors at the meeting of the Council included E. G. Moss, in charge of the Oxford Test Farm, W. J. Liipfert of the J. W. Woolfolk Company and and C. D. Larus, Research Department, Larus & Brother Company, tobacco manufacturers.

The meeting consisted of round-table conferences, field trips to observe experimental tobacco plots and committee meetings. The Council voted to prepare and mimeograph a transcript of the proceedings, which would include an abstract of each topic presented. The recommendations for tobacco insects, as issued for 1938, were not revised, but it was decided to hold a meeting of the Recommendations Committee of the Council in connection with the annual meetings of the American Association of Economic Entomologists scheduled to be held at the Hotel John Marshall, Richmond, Va., late in December.

According to the Secretary, much interest was displayed in the various topics discussed on the program and it was apparent to all that the group conference is very helpful for discussing research problems of mutual interest. The topics discussed on the program included the control of insects in tobacco plant beds, the protection of newly-set tobacco plants from insect attack, the development of standardized methods of experimentation for tobacco insects, the biology of the hornworms and flea beetles, and the problem of finding a satisfactory non-arsenical poison for the hornworms on tobacco. Dr. Z. P. Metcalf gave an interesting review of the early work on the control of tobacco insects in North Carolina, the Secretary reports.

New Commercial Publication

The Crop Protection Institute Circular for August 1, 1938, contains the following paragraph:

"*The Larvacide Log* is a new commercial publication dealing with developments in the field of commercial fumigation with special reference to chloropicrin. The publication is put out by Innis, Speiden and Co., 117 Liberty St., New York, manufacturers of chloropicrin which they put out under the trade name *Larvicide*. We understand the *Log* will be sent to those interested on the subject."

Pest Control Association

Many entomologists will take part in the annual convention of the National Pest Control Association. T. E. Snyder, E. A. Back, W. P. Flint, W. E. McCauley, H. D. Tate, R. T. Cotton, F. L. Campbell, M. H. Swenk, E. R. Barber and J. J. Davis are among those expected. The meeting is scheduled to be held at the Hotel Fontenelle, Omaha, Neb., October 25–26.

Indiana Entomologists

Entomologists of Indiana will hold their annual conference in connection with the annual meeting of the Indiana Academy of Science, at Purdue University, Lafayette, November 5.

Yeager to Illinois

Dr. Lee E. Yeager, until recently with the Bureau of Entomology and Plant Quarantine, was on June 1 appointed to the position of forester with the Illinois Natural History Survey at Urbana.

Dr. Yeager took his bachelor's and master's degrees at Mississippi State College. Later he attended the School of Forestry and Conservation of the University of Michigan, where he was granted M. F. and Ph.D. degrees.

He has had considerable work in the field of forest insects. He joined the Natural History Survey staff from the Division of Forest Insects of the Bureau of Entomology and Plant Quarantine.

New Entomology Head at Cornell

Succeeding Prof. O. A. Johannsen at Cornell University is Charles E. Palm, who on July 1, 1938, the day of Prof. Johannsen's retirement, was appointed professor of entomology and head of the department.

Prof. Palm received the Bachelor of Arts degree from the University of Arkansas in 1931, where he worked with Dr. W. J. Baerg and Dwight Isley. He entered the graduate school of Cornell University in September, 1931. In 1932 and 1933 he served as summer assistant with the New York State Experiment Station at Geneva, and, during the winter months, as assistant in biology to Prof. P. W. Claassen. In 1934 he was appointed an instructor in economic entomology to begin work on the alfalfa snout beetle problem. From October, 1935, to January, 1937, he assisted Prof. C. R. Crosby in extension entomology. From the latter date until his appointment as head of the entomology department he devoted his time to research work on forage crop insects.

Change of Name

The Exterminators Log, unofficial organ of the National Pest Control Association, has changed its name to *Pests*. The new name was used for the first time in the August issue.

Rocky Mountain Conference of Entomologists

The fourteenth annual Rocky Mountain Conference of Entomologists was held at the University of Wyoming summer camp, Centennial, Wyo., August 14–19. A total of 73 persons, representing 11 states and the District of Columbia, attended. Six paper-reading sessions were held. Papers and authors will be listed in the next issue.

CLASSIFIED

Advertisements of commodities for sale or exchange or services will be entered at 50 cents per issue or $2 per year. Advertisements requesting information for use in publications will be charged at the rate of $1 per advertisement to run as long as space permits. Send all notices and cash in advance to Ernest N. Cory, College Park, Md., by the 15th of the month preceding publication.

FOR SALE AT A BARGAIN. JOURNAL OF ECONOMIC ENTOMOLOGY, Vols. 13, 14, 15 and 17 to 23 incl., complete, $32. *Annals* Ent. Soc. Amer., Vols. 14 to 24 incl., complete, $35. *Phytopathology*, Vols. 14 to 20 incl., complete, $23. U.S.D.A. Tech. Buls. 1 to 200, bd. in 5 vols., the lot, $16. U. S. Nat. Mus. Entomological Proceedings, Vols. 57 to 78, bd. in 5 vols., the lot, $14. Indiana State Entomological Anl. Repts. 1 to 6 complete, $4. N.Y. State Ent. Anl. Repts. 1904-05, 1907-08, 1910-11 and 1912-13, unbound, the lot, $2. N.Y. Col. Forestry, Syracuse, Tech. Buls. 1 to 34 incl., Buls. 1 to 16 incl., Circulars 1 to 46 incl. and Leaflets 1 to 3, the lot, $10. *Scientific Monthly*, Vols. 23 to 26 incl. and 29 to 33 incl., the lot, $12.50. With very few exceptions these volumes are beautifully and uniformly bound in half-morocco, with gold titles. Prices, F.O.B. New Orleans. Write Prof. G. Wm. Nott, 1410 Jackson Ave., New Orleans, La.

ASSISTANT to the Editor of the JOURNAL (2 years) seeks change of full-time employment. Now printing production man for eastern land-grant college; formerly editor midwestern state research division (6 years). College, university, experiment station, or science publications work preferred; able also to handle publicity, advertising, or general book and periodical editing. Carroll Chouinard, Box 642, State College, Pa.

FOR EXCHANGE: JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 8, complete, bound; Vol. 7, complete; Vol. 15, complete; Vol. 14, Nos. 5 and 6; Vol. 16, No. 1. Volumes and numbers desired: Vols. 1, 2, 3 and 4, complete; Vol. 5, Nos. 1, 2 and 3; Vol. 11, No. 6, Vol. 16, No. 8. R. R. Parker, U.S.P.H.S., Hamilton, Montana.

EUROPEAN FIRM WANTS REPRESENTATIVES in the U.S.A. for sale of *insecticides* (Barium Fluosilicate). Address: "Insecticide," Care Journal of Economic Entomology, College Park, Maryland.

FOR SALE: JOURNAL OF ECONOMIC ENTOMOLOGY Volumes 1 to 29, lacking seven numbers in Vols. 15 and 16. Annals of the Entomological Society of America, 1910 to 1921 complete, also 1924 to 1934 complete. U. S. D. A. Bureau of Entomology and Plant Quarantine, part of old series bulletins, and new series complete; technical series bulletins complete, also circulars complete. North American Fauna. Experiment Station Record 1905 to 1919. Some National Museum separates and geological survey bulletins; many state publications. Write W. H. Goodwin, North Lima, Ohio.

DICTIONARY of Entomological terms: In preparation. Authors invite correspondence relative thereto and request new words as well as references to articles citing terms or dealing in any way with nomenclature. Parker & Smith, 61 Avenue Alfred Belmontet, St. Cloud, S. & O., France.

FOR SALE from the library of the late W. E. Rumsey: Complete sets—JOURNAL OF ECONOMIC ENTOMOLOGY, first 19 vols. bound in half leather; *Annals*, first 19 vols. bound in buckram; Experiment Station Record, first 54 vols. bound in half leather. Many other publications and bulletins of entomological interest collected over a period of 50 years. Also Contributions from the United States National Herbarium, complete except for No. 1 of Vol. 1. For details write Neal O. Rumsey or Dr. L. M. Peairs, Morgantown, W.Va.

Index to Advertisers

American Association of Economic Entomologists, College Park, Md. vi
Carbide and Carbon Chemicals Corporation, New York City viii
Chipman Chemical Company, Inc., Bound Brook, N.J. v
Journal of Economic Entomology, College Park, Md. vii
McCormick Sales Co., The, Baltimore, Md. ix
Nico-Dust Manufacturing Co., Los Angeles, Calif. iv
Penick and Company, S. B., New York City iv
Sun Oil Company, Philadelphia, Pa. v

ROTENONE - PYRETHRUM

DERRIS ROOT (Derris Elliptica) and **TIMBO** (Lonchocarpus Urucu): Finely powdered standardized to assay 4% or 5% rotenone, plus the other ether extractives.

Also liquid, soft and powdered extracts of Derris.

ROTENONE CRYSTALS: Chemically pure and 90% technical.

PYRETHRUM FLOWERS: Whole—granulated for extraction—finely powdered for dusting—with definite pyrethrins content.

PYREFUME: Concentrated extract of pyrethrum flowers, in Petroleum Distillate, Pine Oil or Alcohol.

S. B. PENICK AND COMPANY
132 Nassau Street, New York City

Largest Botanical Drug Firm in the World

RELIABLE INSECTICIDES

A dependable source of supply of reliable insecticides for buyers in the western half of the United States. For more than 20 years, manufacturers and distributors of dusts, sprays, dusting machines, spreaders and agricultural chemicals.

Manufacturers of genuine *Nico-Dust*, the original nicotine dust. Importers, millers and extractors of pyrethrum and rotenone products. We have the only complete plant on the Pacific coast for milling and extracting botanical plants. Rotenone and pyrethrum powders, extracts, sprays and dusts.

A complete line of vegetable dusts made from standard insecticides such as cryolite, copper, arsenicals, rotenone, pyrethrum, nicotine, etc.

Exclusive Distributors for the famous *Grun Knapsack Duster*.
Distributors for *Root* power and hand guns.

All products manufactured and tested under careful chemical and entomological supervision.

We will be glad to submit samples and we welcome inquiries.

NICO-DUST MANUFACTURING CO.
2412 East 57th St. Los Angeles, Calif.

European Elm Scale

An IMPROVED

SUNOCO

SELF EMULSIFYING **SPRAY**

A 97% Active Spray Material

Pours readily in cold weather.

Ready for instant use. Self-emulsifying in any water. Will not freeze nor deteriorate from season to season. No Waste—No Loss—No Deterioration.

Cresylic Acids and Tar Oils can be used with Sunoco Spray Oil for aphis control on apple trees.

Write for Our Booklet

"SUNOCO FOR ORNAMENTALS"

Safe and Correct Sprays for Scale Insects on Trees and Shrubs

Used by Leading Parks and Fruit Growers

Branches in Leading Cities

Made by SUN OIL COMPANY, *Producers of Blue Sunoco Motor Fuel*

1608 Walnut Street Philadelphia, Pa.

CUBOR

Dusts and Spray

Non-Arsenical Rotenone Insecticides

STABILIZED. Cubor Insecticides are made from choice rotenone-bearing roots of known chemical analysis. Each product is chemically stabilized by being impregnated with a preservative which retards normal decomposition, preserves toxicity, adds to repellent value and improves adhesiveness.

SAMPLES AVAILABLE in the following strengths: CUBOR DUST "50" (.50% rotenone); CUBOR DUST "75" (.75% rotenone); CUBOR SULPHUR DUST (.75% rotenone); CUBOR DUST 100 (1% rotenone); CUBOR DUST 100 TT (1% rotenone plus at least 2½% other associated toxic ingredients on a tobacco dust base); CUBOR SPRAY POWDER (2½% rotenone plus at least 6¼% other associated toxic ingredients). Send requests for samples to Research Department.

CHIPMAN CHEMICAL COMPANY, INC.

BOUND BROOK, N. J.

INDEX TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY

INDEX V NOW READY

Price, $4.50

Foreign postage, 50 cents additional

Members in good standing since 1936 will each receive a copy without charge.

BARGAIN SALE ON INDICES I TO IV

Complete set, $10.00

Foreign postage, $2.00 additional

SINGLE VOLUMES

Index I	$5.00
Index II	4.00
Index III	4.00
Index IV	4.00

Foreign postage, 50 cents additional for each volume

COMMON NAMES OF INSECTS

A complete list of the Common Names of Insects, approved by the American Association of Economic Entomologists, has been issued. Copies are available at 50 cents each.

No library is complete without these publications and every working entomologist constantly needs them for reference.

Order from

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Ernest N. Cory, Secretary, College Park, Md.

JOURNAL OF ECONOMIC ENTOMOLOGY

Prices for back volumes and single numbers of the JOURNAL OF ECONOMIC ENTOMOLOGY are as follows until further notice:

Volume 2, 1909	$3.50
Volume 3, 1910	3.50
Volume 4, 1911	3.50
Volume 5, 1912	3.50
Volume 6, 1913	3.50
Volume 7, 1914	3.50
Volume 8, 1915	4.50
Volume 9, 1916	3.50
Volume 10, 1917	3.50
Volume 11, 1918	4.50
Volume 13, 1920	3.50
Volume 14, 1921	3.50
Volume 15, 1922	4.50
Volume 16, 1923	3.50
Volume 17, 1924	4.50
Volume 18, 1925, except Nos. 1 and 2	3.50
Volume 19, 1926, except No. 1	4.25
Volume 20, 1927	3.50
Volume 21, 1928	3.50
Volume 22, 1929	3.50
Volume 23, 1930	3.50
Volume 24, 1931, except No. 1	3.00
Volume 25, 1932	3.50
Volume 26, 1933, except Nos. 1 and 2	3.50
Volume 27, 1934 Nos. 1, 2 and 3 only, each	1.00
Volume 29, 1936, except Nos. 1 and 3	3.00
Volume 30, 1937, except No. 1	3.50

On volumes mailed to foreign countries an extra charge of 50 cents is made to cover postage.

Price of all *other* single numbers, 75c each.

Ernest N. Cory, Business Manager, College Park, Md.

Fumigants

A wide range of effective chemicals with varying degrees of volatility now available

THESE widely used industrial fumigants are suited to protecting products stored in packages or in bulk. Each one combines a low cost per unit treated with maximum effectiveness and minimum hazard.

ETHYLENE OXIDE, a gas, destroys all the life stages of insects, including their eggs. Proper application will prevent the possibility of dormant insects becoming active when a treated product is removed from storage. It also devitalizes mold spores and certain bacteria. However, Ethylene Oxide is flammable.

"CARBOXIDE"* is a gas composed of the fumigant, Ethylene Oxide, plus sufficient non-inflammable carbon dioxide to render the mixture safe under normal conditions. The carbon dioxide also decreases the dosage and time of exposure necessary. "Carboxide" is especially suited for treating foodstuffs since it leaves no obnoxious odors, tastes or residues.

ETHYLENE DICHLORIDE is a volatile liquid which can be used alone or as a non-flammable mixture with carbon tetrachloride. This mixture, called "Chlorasol," is valuable in fumigating furs, furniture, rugs, grains and a variety of other commodities.

Other aliphatic chemicals of interest to the research entomologist are available. Additional data will be gladly supplied on request.

* Trade-Mark.

CARBIDE AND CARBON CHEMICALS CORPORATION
Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York, N.Y.
PRODUCERS OF SYNTHETIC ORGANIC CHEMICALS

McCORMICK INSECTICIDES

STANDARDIZED ANALYTICALLY AND BIOLOGICALLY

McCORMICK'S Pyrethrum and Derris Products are standardized analytically and biologically by graduate chemists and entomologists in the McCormick Laboratories—the most complete testing laboratories in the insecticide industry.

The quality of ingredients used in these insecticides is verified at all times by chemical assay, and their killing power is tested by actual applications to live insects.

Write for free spraying and dusting chart No. 129.

RED ARROW GARDEN SPRAY: The most highly concentrated pyrethrum soap spray on the market.

ROTENONE GREENHOUSE SPRAY: A new product containing 1½% rotenone plus the other active ingredients of derris root, a specific control for red spider.

RED ARROW GARDEN DUST: Contains ¾% rotenone and 30% wettable sulphur. Used as dust or combine with water as wash.

RED "A" SOAP: A liquid neutral potash coconut oil soap with 40% soap content. It is an insecticide itself—also an ideal activator and spreader for use with Red Arrow, reducing the cost of the spray solution.

BLACK ARROW DUST—5000: A combination of very finely ground pyrethrum with other insecticidal factors.

BLACK ARROW—2700: A special pyrethrum dust used only by the mushroom industry.

McCORMICK'S PYRETHRUM POWDER: Ground extremely fine—contains more killing particles per pound—remains suspended in the air longer.

McCORMICK'S DERRIS AND CUBÉ POWDERS: Finest ground powders in the world. Standardized at 4% and 5% rotenone.

McCORMICK'S ROTENONE DUST ¾%: Contains ¾% rotenone, plus all the other toxic ingredients of rotenone-bearing roots.

ROSIN RESIDUE EMULSION: A newly developed spreader and sticker. Used with other insecticides.

THE McCORMICK SALES CO.

Distributors of Pyrethrum and Derris Insecticides

BALTIMORE **MARYLAND**

Hotel Accommodations for the Annual Meeting

The Hotel John Marshall, Richmond, Va., headquarters for the Annual Meeting, December 27–31, of the American Association of Economic Entomologists, has set aside 200 rooms for members of the Association. Any of these rooms which have not been reserved by November 15 will be released for reservations by members of other associations.

Reservations should be made through Leonard K. Baber, Director of Advertising and Sales, Richmond Hotels, Richmond, Va.

Prices of rooms at the Hotel John Marshall are as follows: with single or double beds, $3.50–$7.00; with twin beds, $6.00-$8.00.

Other hotels near the Association headquarters are the Reuger, Richmond, Murphy and Capitol.

Association members wanting to stay in private homes, or those unable to secure the hotel accommodations they want, should communicate with Foley F. Smith, Chairman, Housing Committee, A. B. C. Laboratory, Richmond, Va.

Symposium Papers on Insect Populations

The editors and business manager of *Ecological Monographs* have agreed to publish the papers delivered at the joint symposium of "Insect Populations" sponsored by the American Association of Economic Entomologists, the Entomological Society of America and the Ecological Society of America as a single number of *Ecological Monographs*. The price for this number to non-subscribers of *Ecological Monographs* is $1.00. Those wishing to have a copy of the symposium papers are requested by the publishers of *Ecological Monographs* to send a remittance of $1.00 at once to the Duke University Press, Durham, N. C.

Papers for the Annual Meeting

Members of the Association who have in mind preparation of papers for the next annual meeting are asked by officers of the organization to see that titles, brief abstracts, information as to length of time of presentation and other pertinent data are in the hands of the Secretary, Dr. Ernest N. Cory, College Park, Md., not later than November 1.

At the annual meeting of the Publications Committee held at the time of the last meeting of the American Association of Economic Entomologists at Indianapolis, December 27–31, 1937, it was decided that henceforth the program for the annual meeting will be issued separately, instead of with the December issue of the JOURNAL OF ECONOMIC ENTOMOLOGY. Publication of the program in the JOURNAL has in the past tended to delay issue of the December number.